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EXTRAORDINARY

PART II—Section 3—Sub-section (i)

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MINISTRY OF WORKS, HOUSING AND SUPPLY

NOTIFICATION

New Delhi, the 3rd March 1958

G S.R. 219—The following draft of certain further amendment to the Indian Boiler Regulations, 1950, which the Central Boilers Board proposes to make in exercise of the power conferred by section 28 of the Indian Boilers Act, 1923 (5 of 1923), is published as required by sub section (1) of section 31 of the said Act for the information of all persons likely to be affected thereby, and notice is hereby given that the said draft will be taken into consideration on or after the 15th April, 1959

Any objections or suggestions which may be received from any person with respect to the said draft before the date so specified will be considered by the Central Boilers Board Such objections or suggestions should be addressed to the Secretary, Central Boilers Board, Ministry of Works, Housing and Supply, North Block, New Delhi.

Draft Amendments

In the said Regulations—

1 For the existing heading "ATTACHMENT OF FLANGES" above regulation 353, the following shall be substituted, namely.—

"FLANGES"

For regulation 353 the following regulation shall be substituted, namely —

'353 (a) *Flanges for Carbon Steel Pipes*—The material for carbon steel flanges, where forged or cut from the plates (excluding branches forged integral with the pipe) shall be made of steel produced by Open Hearth or an electric process, acid or basic Flanges shall be made without a weld and shall be free from lamination or other defects They may be secured by screwing, riverting or welding

Blank flanges shall be of mild steel or cast steel and shall be not less in thickness than the flanges to which they are attached

The material shall comply with the requirements specified in the table below —

TABLE

Carbon Steel for Flanges

Flanges in accordance with Appendix E	Tensile strength tons per sq in	Minimum elongation on test piece C per cent	Sulphur (max) Per cent	Phosphorus max Per cent
TABLES D to J inclusive	23-30	30	0 06	0 06
TABLES K to L inclusive	26-32	Sum of tensile strength and elongation not less than 57	0 05	0 05

(b) *Flanges of alloy steel pipes.*

The material for alloy steel flanges, where forged or cut from plates (excluding branches forged integral with the pipe) shall be made of steel produced by open hearth or electric process acid or basic Flanges should be made without a weld and shall be free from laminations or other defects

The material of alloy steel flanges shall comply with the requirements specified in the table below:—

ALLOY STEEL FLANGES

Classification	Carbon % max.	Silicon % max.	Sulphur % max.	Phosphorus % max.	Minnese % max.	Molybdenum % max.	Chromium % max.	Ultimate tensile stress Minimum	Percentage elongation on gauge length of 4/A.
Carbon Molybdenum Steel	0·30	0·35	0·04	0·04	0·75	0·65	..	31 tons/sq. in.	Not less than 700 divided by tensile strength in tons per square inch.
Chromium Molybdenum Steel :— Grade I	0·20	0·40	0·04	0·04	0·75	0·65	1.10	31 tons/sq. in.	Not less than 700 divided by tensile strength in tons per square inch.
Grade II	0·15	0·50	0·04	0·04	0·60	1·00	2·25	31 tons/sq. in.	Not less than 700 divided by tensile strength in tons per square inch.

The materials for flanges should be similar to those of the pipes to which they are to be attached.

The flanges are to be so designed that the total stress induced in them does not exceed the maximum permissible stress shown in the table below:—

Maximum permissible working stress in lbs. per sq. in. for alloy steel flanges.

Classification	Upto & including 600°F	650°F.	700°F.	750°F.	800°F.	850°F.	900°F.	950°F.	1000°F.	1050°F.	1100°F.	1150°F.	1200°F.
Carbon Molybdenum Steel—	17500	17500	17500	17500	16900	15000	..						
Chromium Molybdenum Steel:—													
Grade I	17500	16800	16150	15500	14850	14200	13100	11000	7500	5000	2800		
Grade II	17500	17500	17500	17500	17500	16000	14000	11000	7800	5800	4200	3000	2000

Stress values for intermediate temperatures may be determined by linear interpolation.

Blank flanges of alloy steel shall be not less in thickness than the flanges to which they are to be attached. The material shall have the same composition as those of the flanges.

(c) *Non-ferrous Flanges*

Material for non-ferrous flanges shall be of bronze.

Bronze castings shall consist of not less than 86 per cent of copper and not more than a total of 0·15 per cent of elements other than tin, nickel and lead. The ultimate tensile stress and the elongation percentage shall not be less than those prescribed under Regulation 282(a)(iv).

2. For regulation 358, the following shall be substituted, namely:—

"358. *Flanges of copper pipes.*—Flanges of copper pipes may be made of bronze. When flanges are attached to copper pipes by brazing they shall be secured in such additional way (*e.g.* by riveting the ends or forming a conical end so as to fit into the conical bore in the flange) that the resistance to withdrawal from the flange does not depend wholly on the brazing.

3. The following heading shall be inserted after regulation 364, namely:—

"STEAM RECEIVERS, SEPARATORS CATCH WATERS AND SIMILAR VESSELS"

and for regulations 365 and 366, the following shall be substituted, namely:—

"365. (a) MATERIALS

(1) *Plates, Bars, Sections and Rivets.*—Materials for plates, bars, sections and rivets used in the construction of Steam Receivers, Separators, Catch Waters and Similar Vessels shall comply in all respects with the requirements of relevant regulations of Chapters II and V, depending upon the mode of construction.

(2) *Branches, Bosses and Drain Pockets.*—Branches, bosses and drain pockets may be solid forged, fabricated by fusion welding, machined from solid bars or made from tubes.

(3) *Flanges.*—Material for flanges shall comply with the appropriate provisions of Regulation 353.

(4) *Forgings.*—Forgings shall comply with the requirements of Regulation 243

(5) *Steel Castings.*—Steel castings for shells or pressure parts of shell shall comply with Regulations 73 to 80.

(b) CONSTRUCTION AND WORKMANSHIP

(1) *Shell Ends*—Shell ends formed separately from the shell may be dished or flat. Alternatively, the ends of the shell may be forged down and closed by manhole doors or by plugs or branches welded-in.

(2) *Dished Ends*—Each dished end shall be in one piece made from one plate and the shape shall conform to the requirements of Regulation 275. Dishing and peripheral flanging shall be done by machine. Cold flanging shall not be adopted. All plates which have been dished, flanged or locally heated, shall afterwards be efficienty heat treated for the purpose of relieving internal stresses, unless during the last stage of manufacture, they have been uniformly heated throughout to a suitable temperature. Care shall be taken to see that the flanges are cylindrical, of good surface and free from local irregularities.

Where flats are pressed in dished ends for the attachment of connections they shall be formed with an ample radius at the junctions of the flat and curved surfaces and shall be free from sharp corners and tool marks

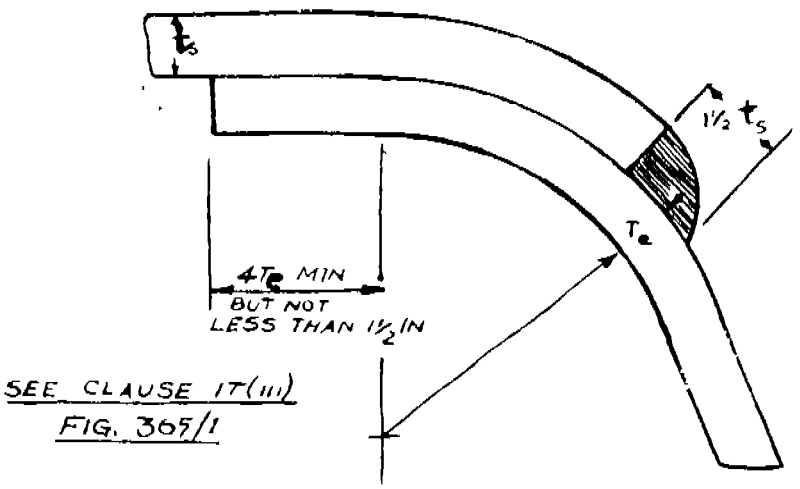
Dished ends shall be attached to the cylindrical part of the shell by one of the following methods:—

(i) *Riveting*—Dished ends shall be machined to fit closely into the cylindrical part of the shell and flogging or hammering in the fitting of ends shall not be adopted. The caulking edges of all flanged plates shall be machined or flame cut by machine.

(ii) *Welding with butt joints of the single or double U or V type*—Where the internal diameter of the shell is 24 ins. or over, the joints shall, in all cases, be welded from both sides of the plate. Where the internal diameter of the shell is less than 24 ins., the joints may be welded from one side only, when efficient welding from inside is considered impracticable

(iii) *Inserting, convex side outwards, into the cylindrical part of the shell which shall afterwards be hammered over at a forging temperature and welded round the periphery.*—The dished end shall be a tight fit in the cylindrical part of the shell and the length of the cylindrical portion of the dished end shall be not less than four times the thickness of the dished end but not less than 1½ ins. This method may be used where the shell diameter does not exceed 36 ins. and

the thickness of the cylindrical part of the shell does not exceed 1 in., (See Figure No. 365/1), except that it shall not be permitted where the design pressure exceeds 400 lbs /sq. in or where the design temperature exceeds 750°F.



THIS TYPE IS NOT PERMITTED WHERE RECEIVER EXCEEDS 36IN. DIA OR WHERE DESIGN PRESSURE EXCEEDS 400 LB / SQ IN OR WHERE DESIGN TEMP EXCEEDS 750° F OR WHERE THICKNESS EXCEEDS 1IN

Dished ends shall not be secured to the cylindrical part of the shell merely by Fillet Welding round periphery without any mechanical lock.

(3) *Flat Ends.*—Flat ends shall be of forged steel or plate steel and shall be welded to the cylindrical part of the shell or bolted to flanges which shall be attached to the cylindrical part of the shell in accordance with Regulation 356 or 357.

The attachment of flat ends shall be by one of the methods shown in **Figure** Nos. 365/2, 365/3, 365/4 and 365/5.

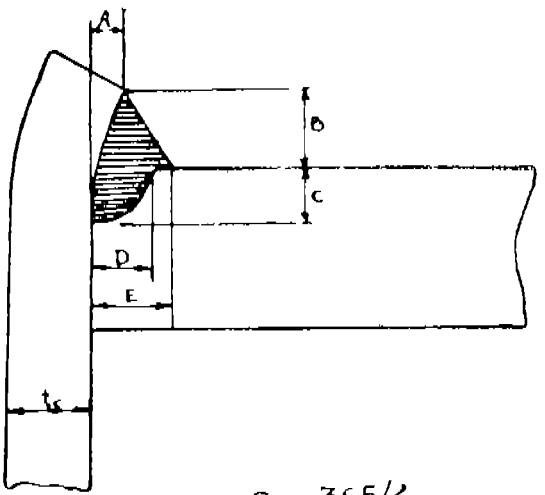


FIG. 365/2

A =	$\frac{1}{3}\ t_s$ BUT NOT LESS THAN $\frac{3''}{16}$
B =	t_s
C =	$\frac{1}{2}\ t_s$ BUT NOT LESS THAN $\frac{5'}{10}$
D =	$\frac{2}{3}\ t_s$ BUT NOT LESS THAN $\frac{3''}{8}$
E =	t_s BUT NOT LESS THAN $\frac{3''}{8}$

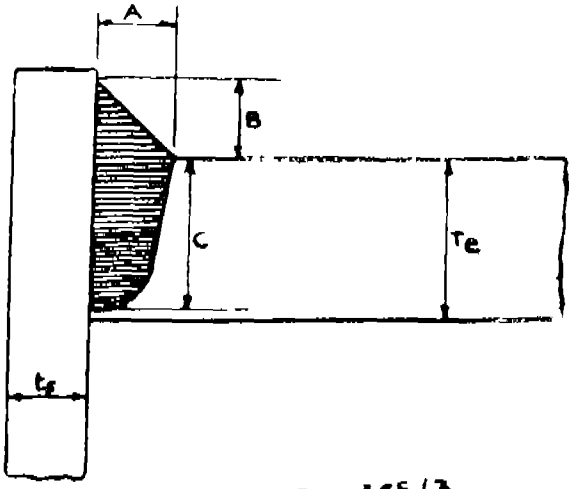


FIG 365/3

A =	t_s
B =	t_s
C =	$2t_s$ OR $T_e - \frac{5}{8}$" WHICHEVER IS SMALLER

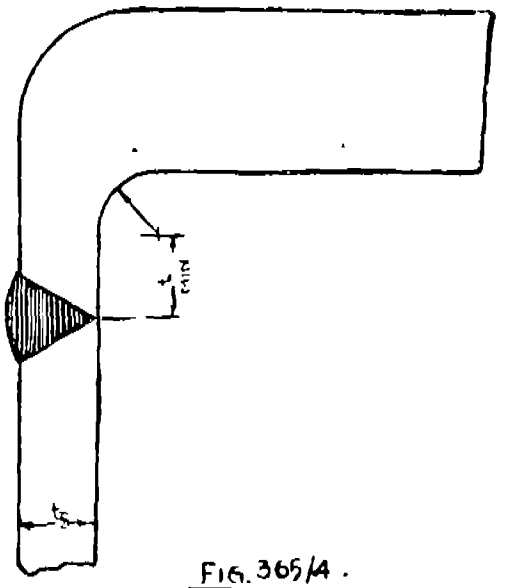


FIG. 365/4.

TO BE WELDED FROM BOTH SIDES OF THE SHELL PLATE BUT WHERE THIS IS IMPRACTICABLE CARE SHALL BE TAKEN TO ENSURE FULL PENETRATION AND BACKING STRIPS MAY BE USED

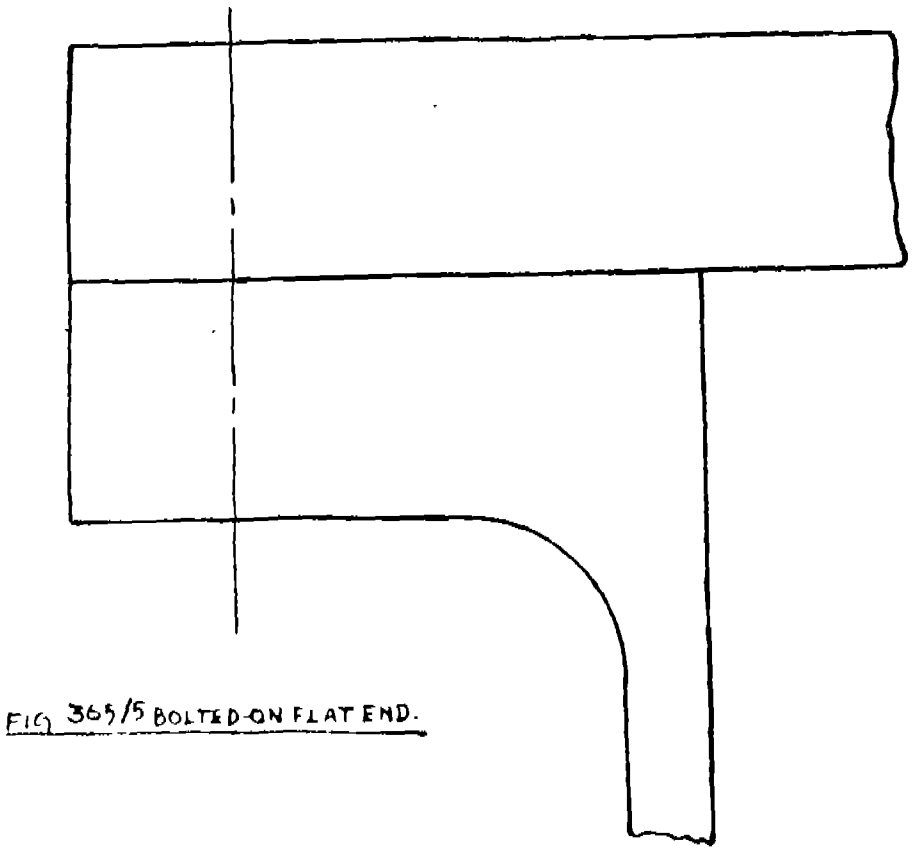


FIG 365/5 BOLTED-ON FLAT END.

When ends are attached as shown in Figure 365/4, welding shall be from both sides of the shell plate where practicable. Where welding is done from one side only, care shall be taken to ensure full penetration using backing strips.

(c) ACCESS TO SHELLS

At least one manhole shall be provided to allow access for thorough cleaning and inspection, except that where the shell is too small to permit entry, cleaning and inspection openings of sufficient size and number shall be provided, Where there is an elliptical opening in the cylindrical part of the shell, the minor axis shall, wherever practicable, be parallel to the longitudinal axis of the shell.

(d) COMPENSATING RINGS TO OPENINGS AND DOORS

The material, construction and workmanship of compensating rings and doors shall comply with the appropriate Regulations of Chapters, II, III and XII.

(e) BRANCHES AND OTHER CONNECTIONS

Connections to shells shall be made by means of branches, pressed plate saddles, forged pads or bosses. Alternatively, where the thickness of the shell is sufficient to allow a suitable surface to be obtained, connections may be attached directly to the shell, provided that the minimum thickness at the hole in the shell is not less than the thickness required for the design pressure and temperature, considering the shell as being unpierced and that the diameter of the hole does not exceed the maximum diameter of an uncompensated hole as defined in Regulations 170 and 279. Studs for securing such connections shall have a full thread holding in the shell for a length of at least one diameter and the stud holes shall not penetrate the whole thickness of the shell. All holes for bolts, studs and rivets in branches, saddles and forged pads shall be drilled. Where such connections are secured by welding alone, a minimum of two runs of metal shall be deposited at each weld, except for seal welds. Each run of weld metal shall be thoroughly cleaned and free from slag before the next run is deposited. The final finish of the welds shall be such that change of section from shell to branch is gradual and free from sharp notches. Where the diameter of the shell is 24 inches and over, welding shall be from both sides of the plate. Where the internal diameter of the shell is less than 24 inches, external and internal welds shall be applied unless it is considered that efficient welding from both sides is impracticable. This does not apply to the methods of attachment shown in Figures 365/6 and 365/7 in which the welding shall always be from both sides.

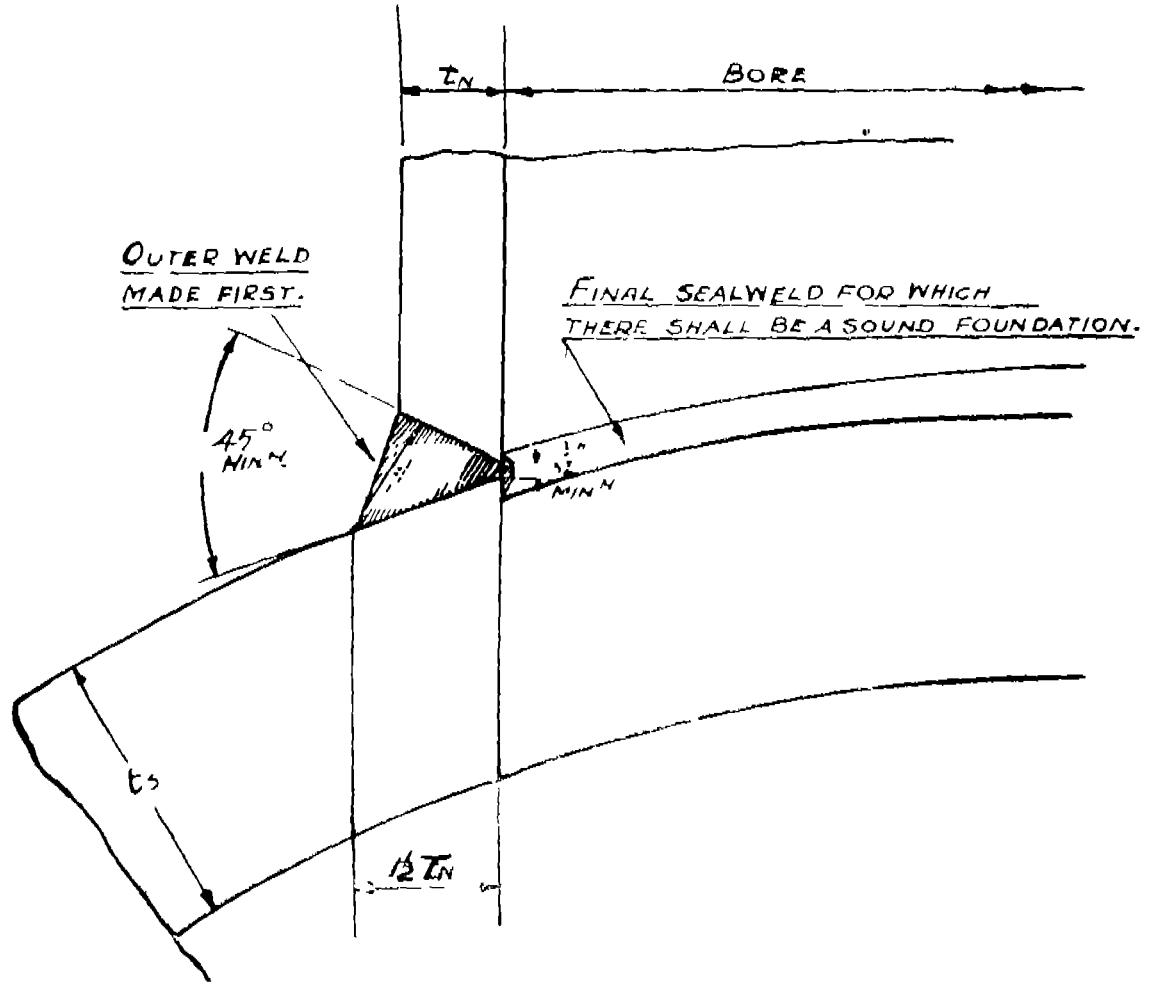


FIG 365/6

HERE THE APPLICATION OF THE SEALWELD FROM INSIDE THE VESSEL IS PRACTICABLE, THIS TYPE IS NOT PERMITTED UNLESS THE BORE OF THE BRANCH IS 4" OR LARGER AND THE LENGTH FROM FACE OF BRANCH OUTSIDE OF SHELL DOES NOT EXCEED THE FOLLOWING -

BORE OF BRANCH	LENGTH OF BRANCH
4"	9"
5"	10"
6"	12'
7" TO 10" INCLUSIVE	15"
OVER 10"	18"

NOTE:-

THE ABOVE ARE NOT RECOMMENDED BRANCH LENGTHS AND BRANCHES SHOULD BE AS SHORT AS POSSIBLE.

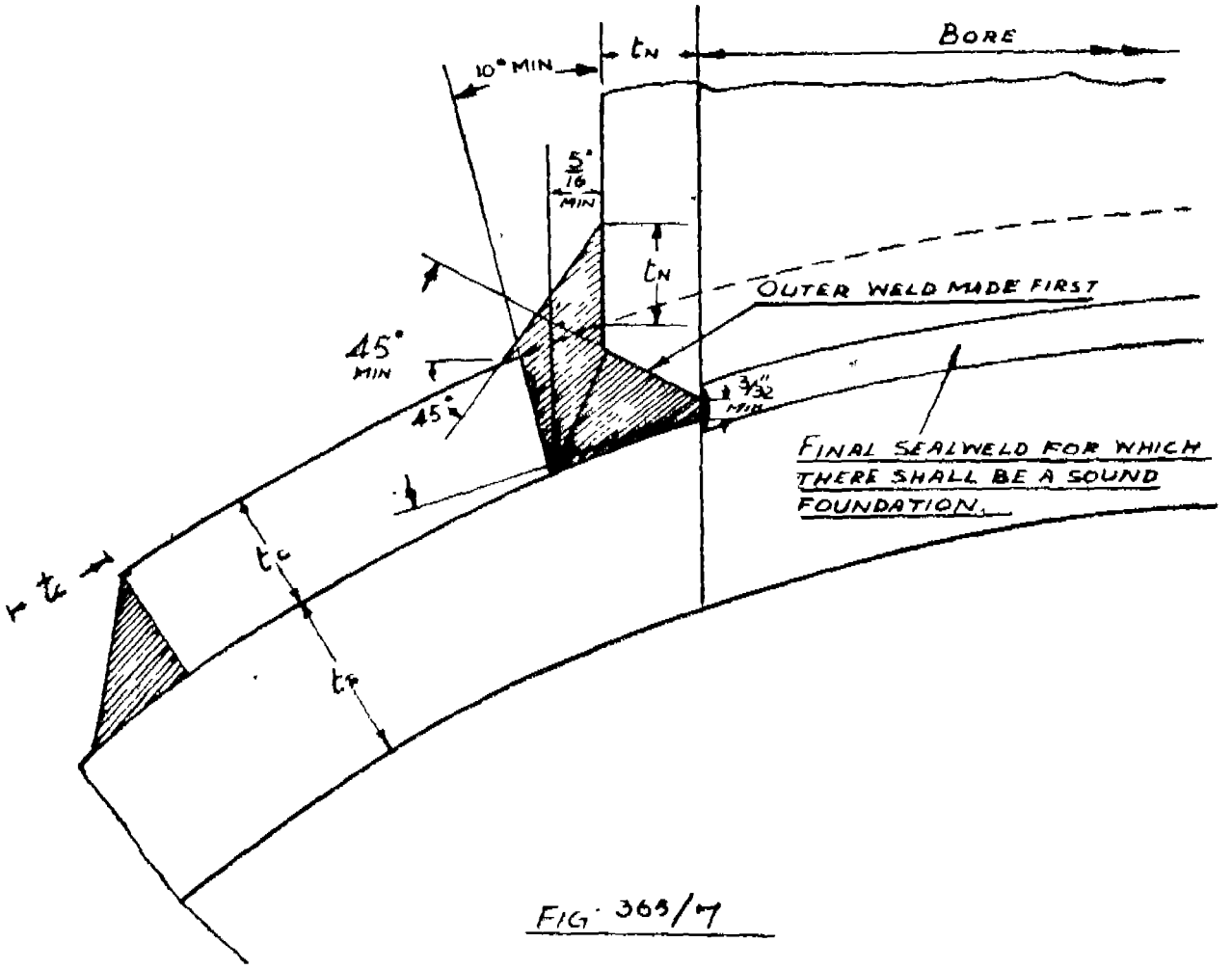


FIG. 365/7

WHERE THE APPLICATION OF THE SEALWELD FROM INSIDE THE VESSEL IS IMPRACTICABLE, THIS TYPE IS NOT PERMITTED UNLESS THE BORE OF THE BRANCH IS 4" OR LARGER AND THE LENGTH FROM FACE OF BRANCH TO OUTSIDE OF SHELL DOES NOT EXCEED THE FOLLOWING:-

BORE OF BRANCH	LENGTH OF BRANCH
4"	9"
5"	10"
6"	12"
7" TO 10" INCLUSIVE	15"
OVER 10"	18"

NOTE:-

THE ABOVE ARE NOT RECOMMENDED BRANCH LENGTHS AND BRANCHES SHOULD BE AS SHORT AS POSSIBLE.

Branches, pressed plate saddles, forged pads of bosses shall be secured to the shell by one of the following methods:—

(i) *Rivetting*

(ii) *Welding.*

(iii) *Screwing and seal welding.*

Where branches are rivetted on, the flange in contact wit hthe sheel shall bed closely. The caulking edges shall be machined or flame cut by machine.

Methods of attachment for branches secured by welding are shown in Figures 365/6 to 365/29.

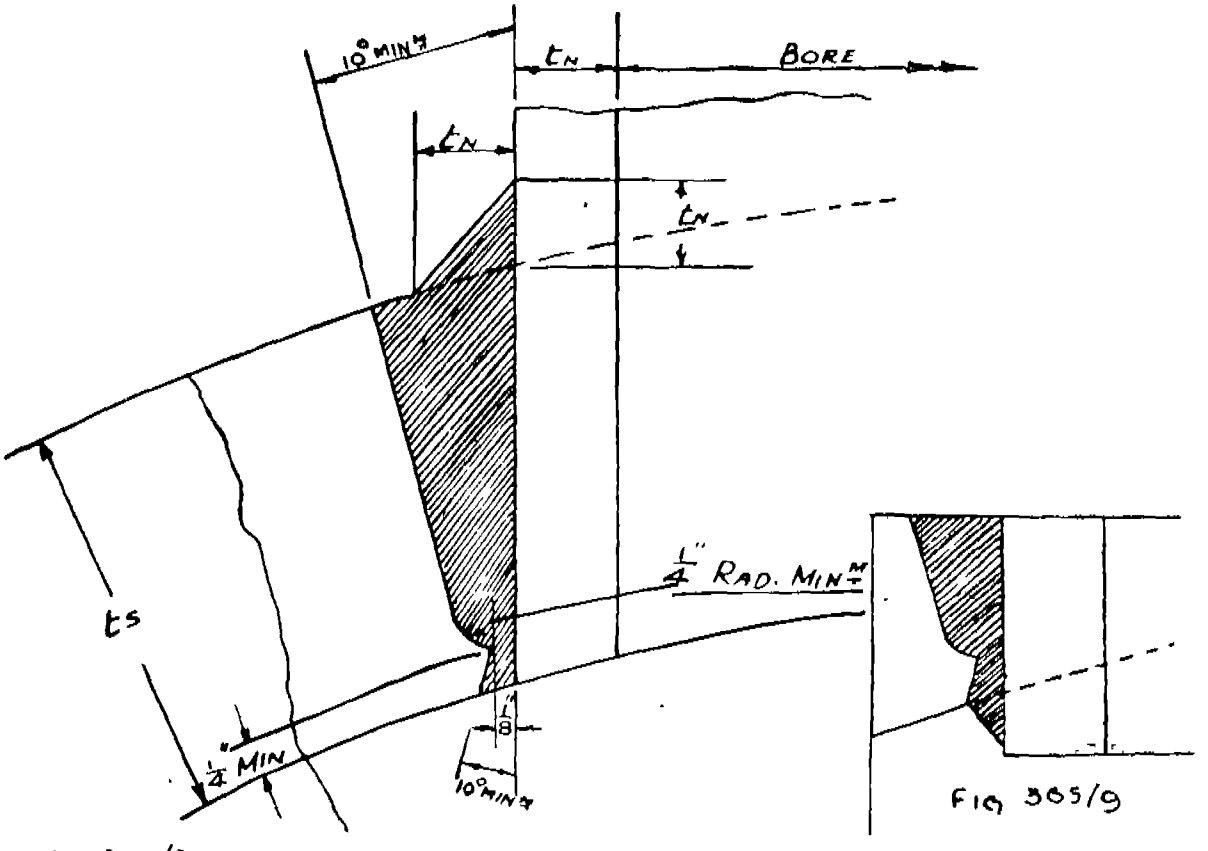


Fig 365/8

Fig 365/9

WELDING PROCEDURE FOR TYPES SHOWN IN FIGS. NOS 365/8 AND 365/9 TO BE AS FOR DOUBLE WELDED BUTT JOINT. OUTER WELD TO BE MADE FIRST BACK OF OUTER WELD TO BE CHIPPED OUT. BEFORE COMMENCEMENT OF INNER WELD BUT DEEP PENETRATION WELDING MAY BE USED SUBJECT TO PROOF OF REQUISITE PENETRATION BEING PRODUCED BY THE MANUFACTURER WHERE CALLED FOR BY THE INSPECTING AUTHORITY.

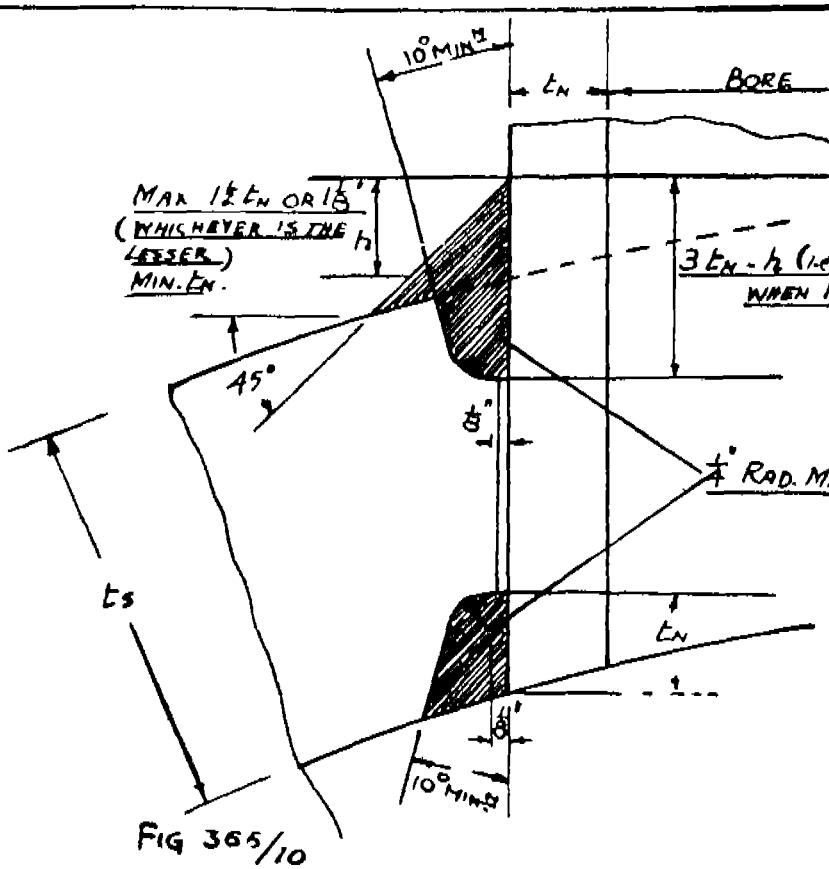


FIG 365/10

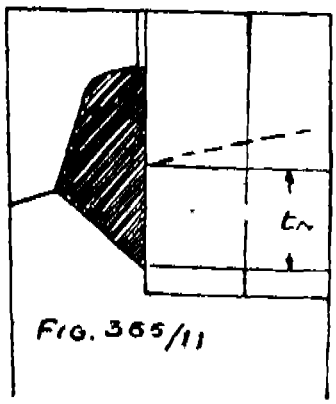


FIG. 365/11

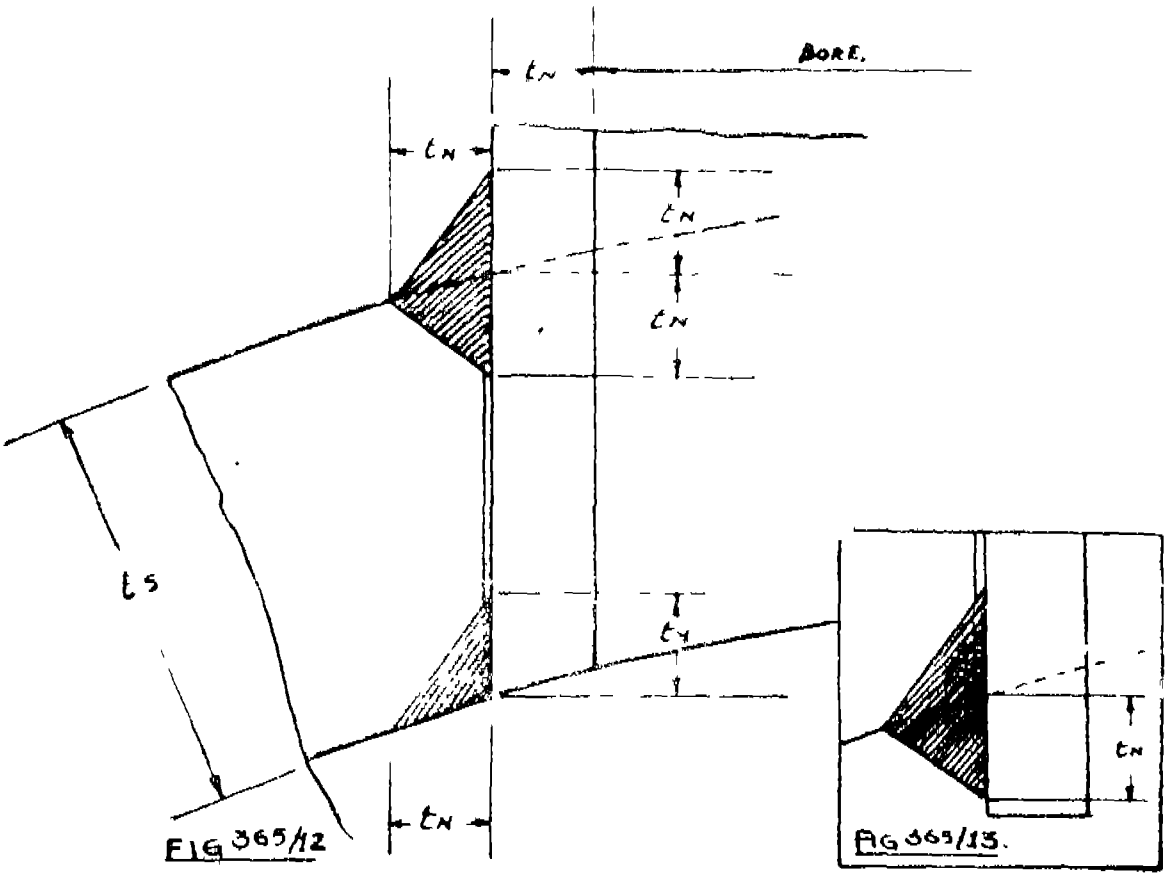


FIG 365/12

FIG 365/13.

THE TYPES SHOWN IN FIGS. 365/12 AND 365/13 ARE ONLY PERMITTED WHERE THE ELECTRODES AND TECHNIQUE TO BE USED HAVE BEEN SHOWN, BY SEPARATELY PREPARED TEST SPECIMENS, TO GIVE FULL PENETRATION WITH SOUND WELD METAL AT THE ROOT OF THE GROOVES. THEY ARE NOT PERMITTED WHERE THE BORE OF THE BRANCH EXCEEDS 5 INCHES.

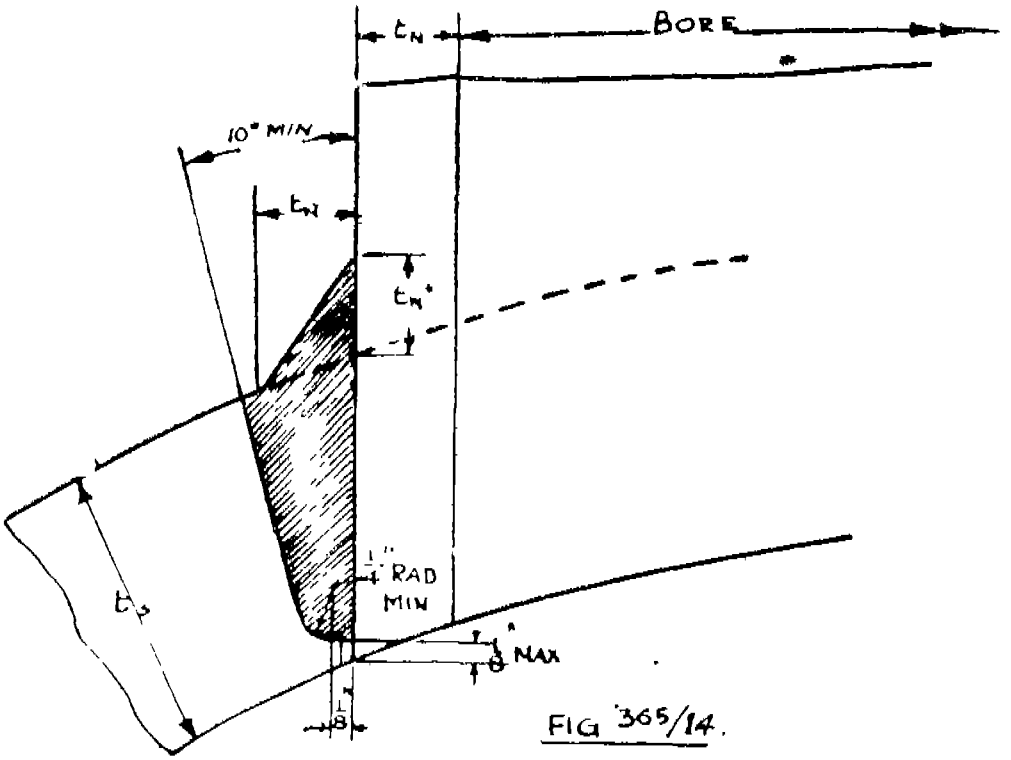


FIG 365/14.

THE TYPE SHOWN IN FIG 365/14 IS NOT PERMITTED WHERE THE INSIDE OF THE VESSEL IS ACCESSIBLE FOR WELDING FIG 365/13 IS PREFERRED WHERE THE INSIDE OF THE BRANCH IS ACCESSIBLE FOR WELDING WHERE IT JOINS THE SHELL.

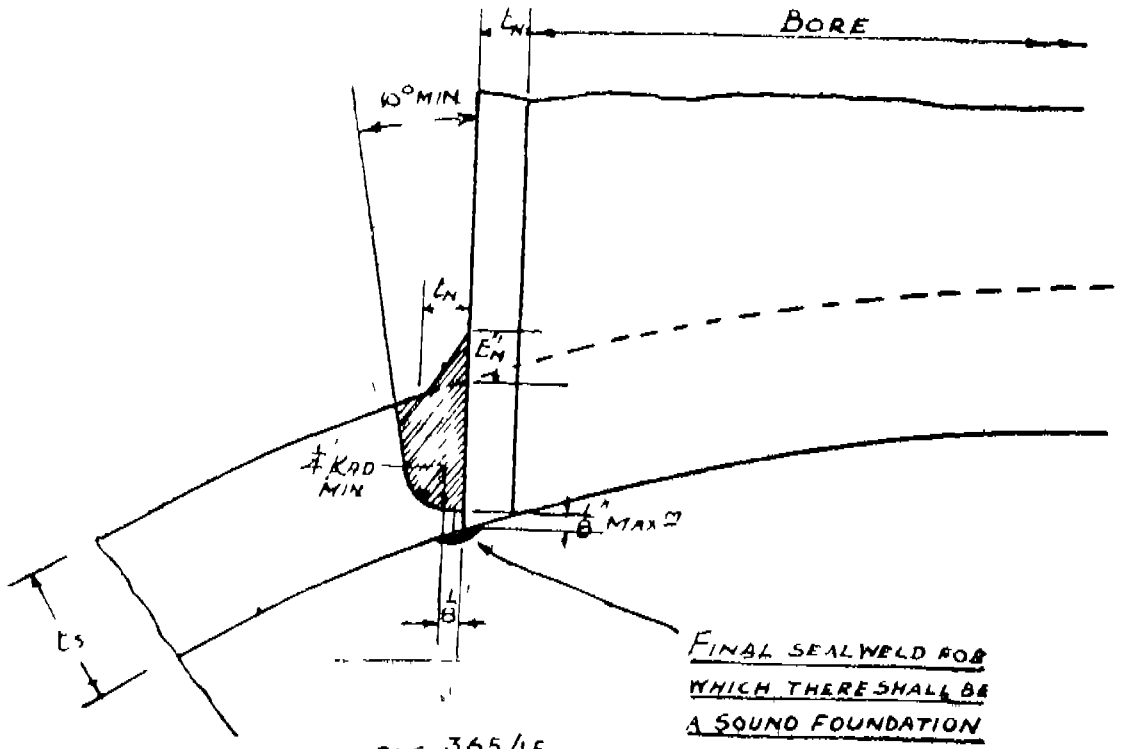


FIG 365/15

THE TYPE SHOWN IN FIG 365/15 IS NOT PERMITTED WHERE THE SHELL THICKNESS EXCEEDS 1 INCH

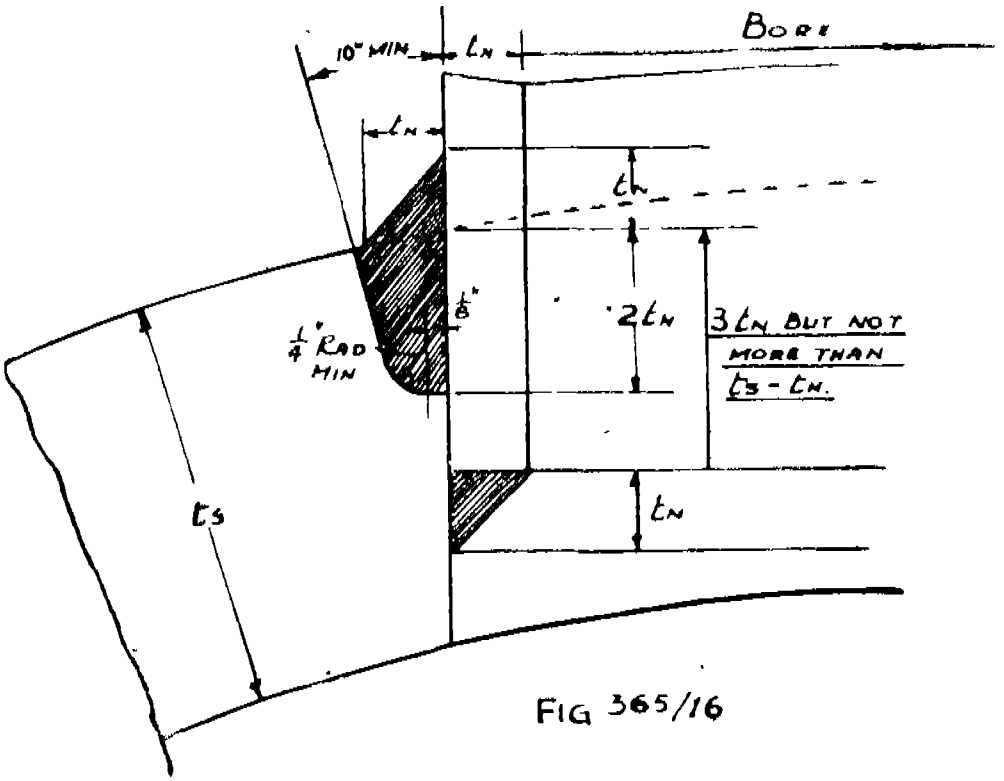


FIG 365/16

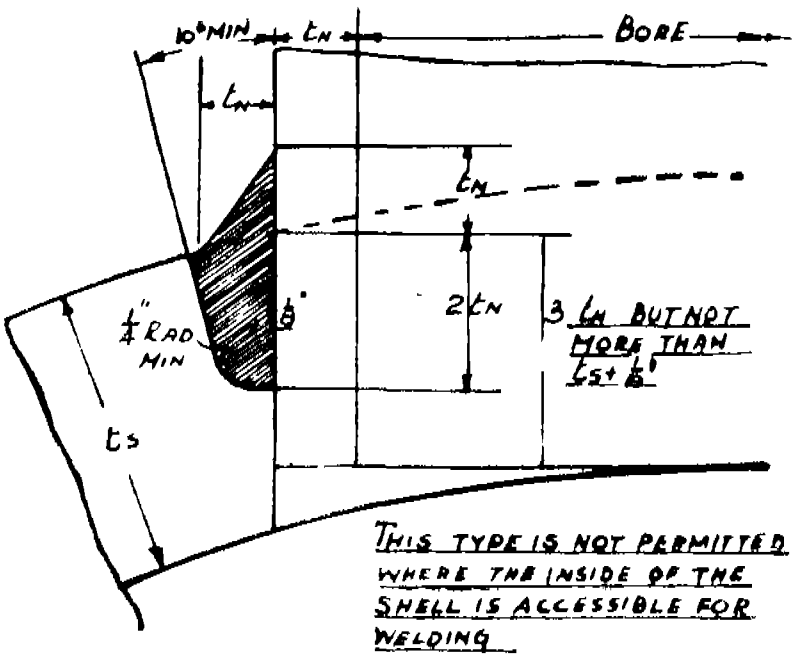


FIG. 365/17

THE TYPES SHOWN IN FIGS 365/16 AND 365/17 ARE ONLY PERMITTED FOR DRAIN POCKETS AND LIKE CONNECTIONS WHERE THE STRESS OTHER THAN THAT DUE TO INTERNAL PRESSURE IS INSIGNIFICANT

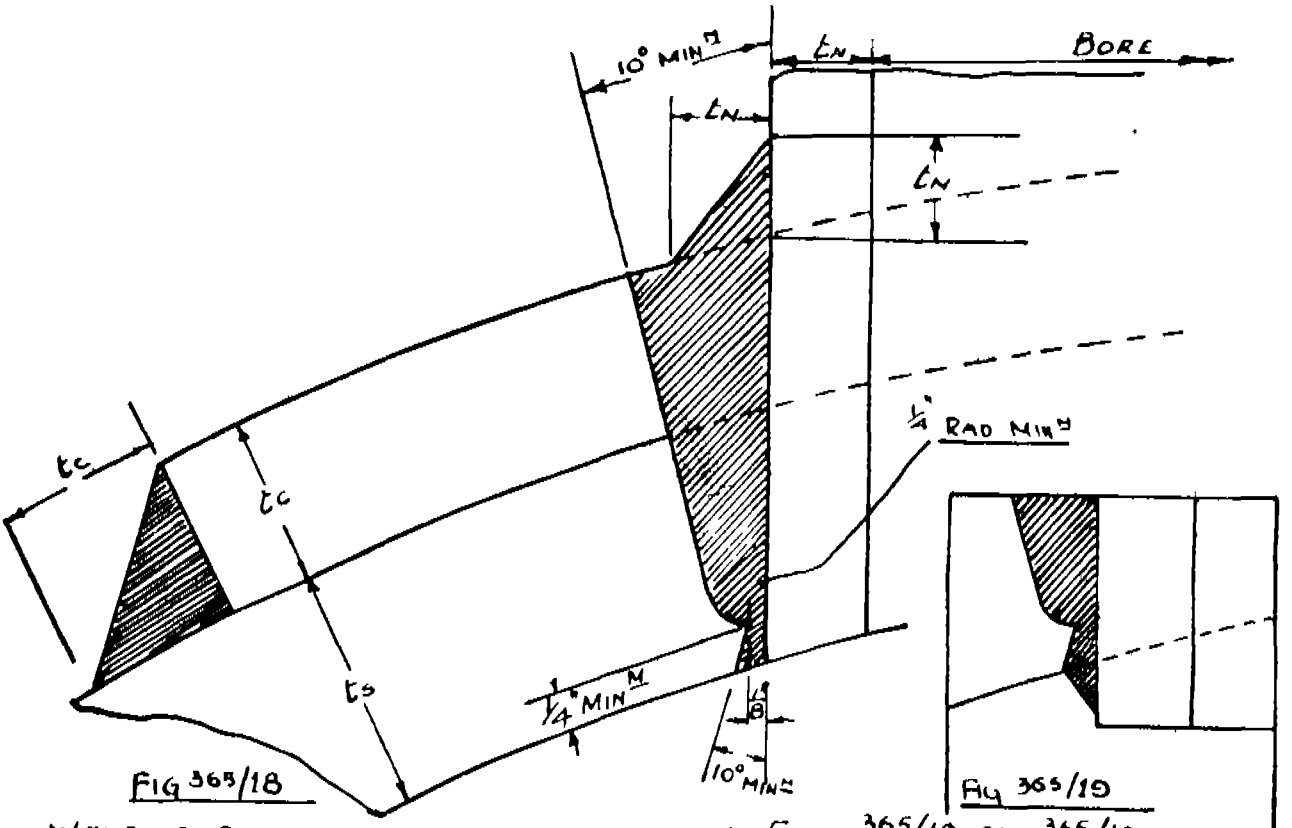


FIG 365/18 FIG 365/19

WELDING PROCEDURE FOR TYPES SHOWN IN FIGS 365/18 AND 365/19 TO BE AS FOR DOUBLE WELDED BUTT JOINT OUTER WELD TO BE MADE FIRST BACK OF OUTER WELD TO BE CHIPPED OUT BEFORE COMMENCEMENT OF INNER WELD, BUT DEEP PENETRATION WELDING MAY BE USED SUBJECT TO PROOF OF REQUISITE PENETRATION BEING PRODUCED BY THE MANUFACTURER WHERE CALLED FOR BY THE INSPECTING AUTHORITY.

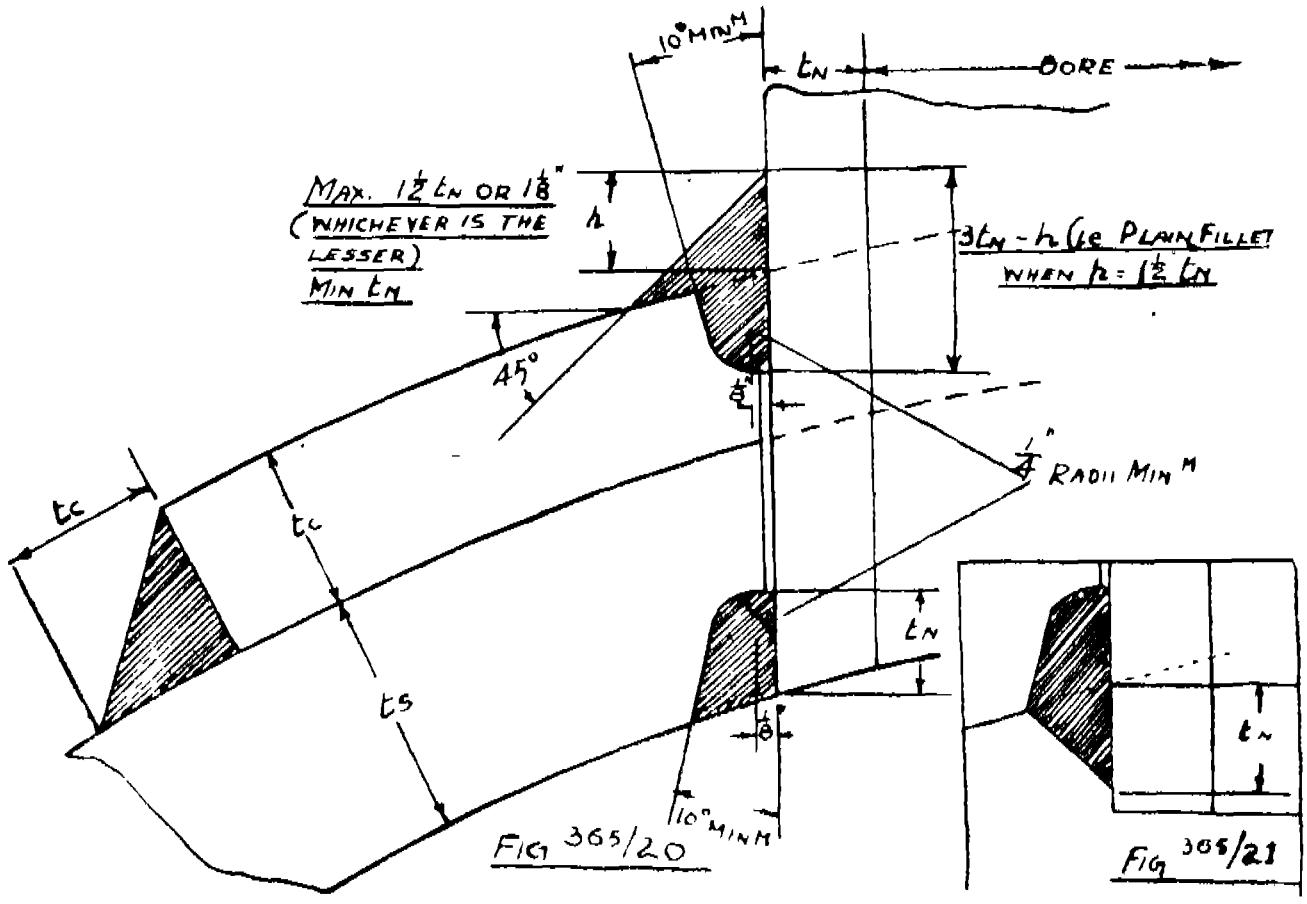


FIG 365/20

FIG 365/21

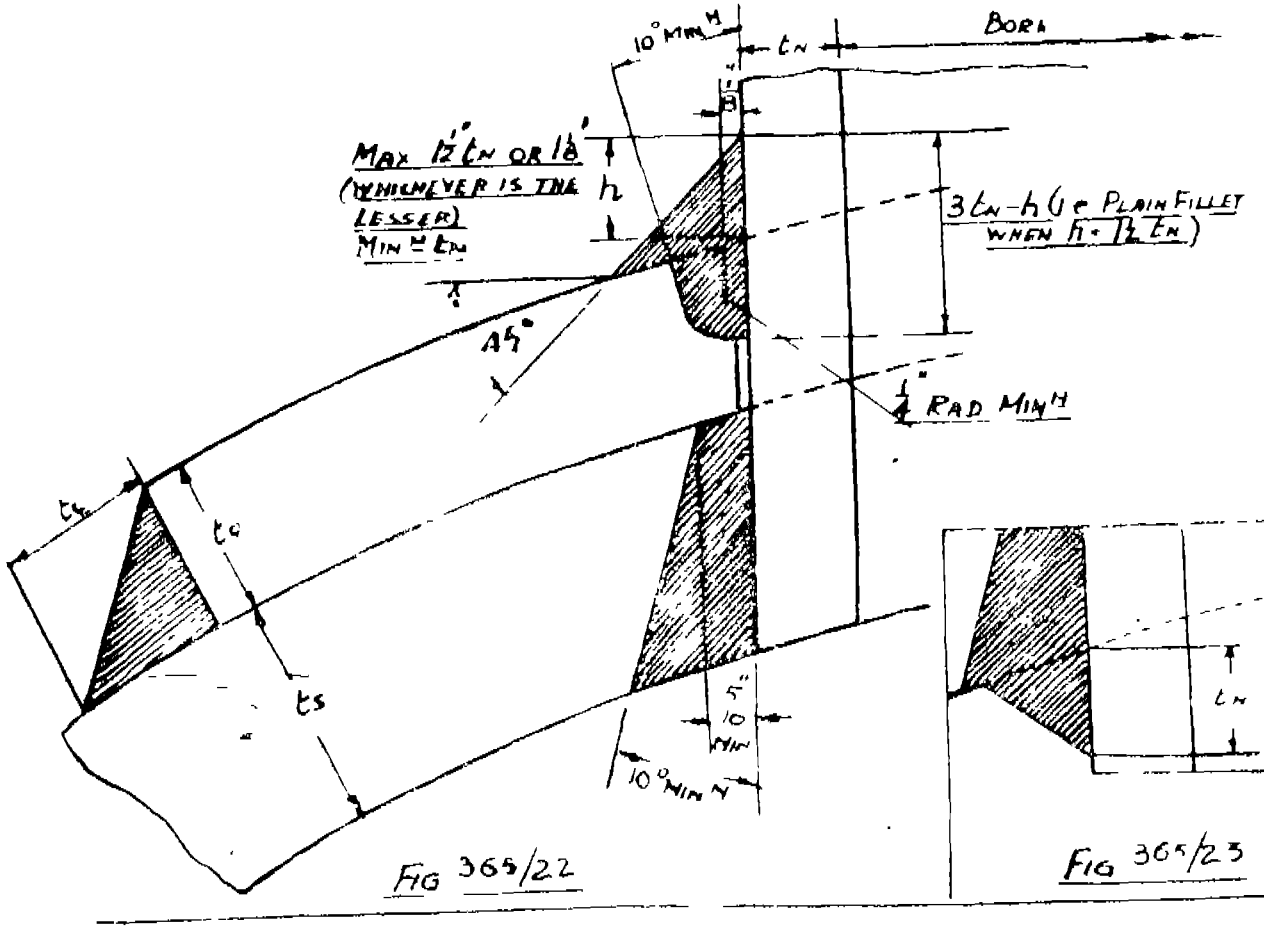


FIG 365/22

FIG 365/23

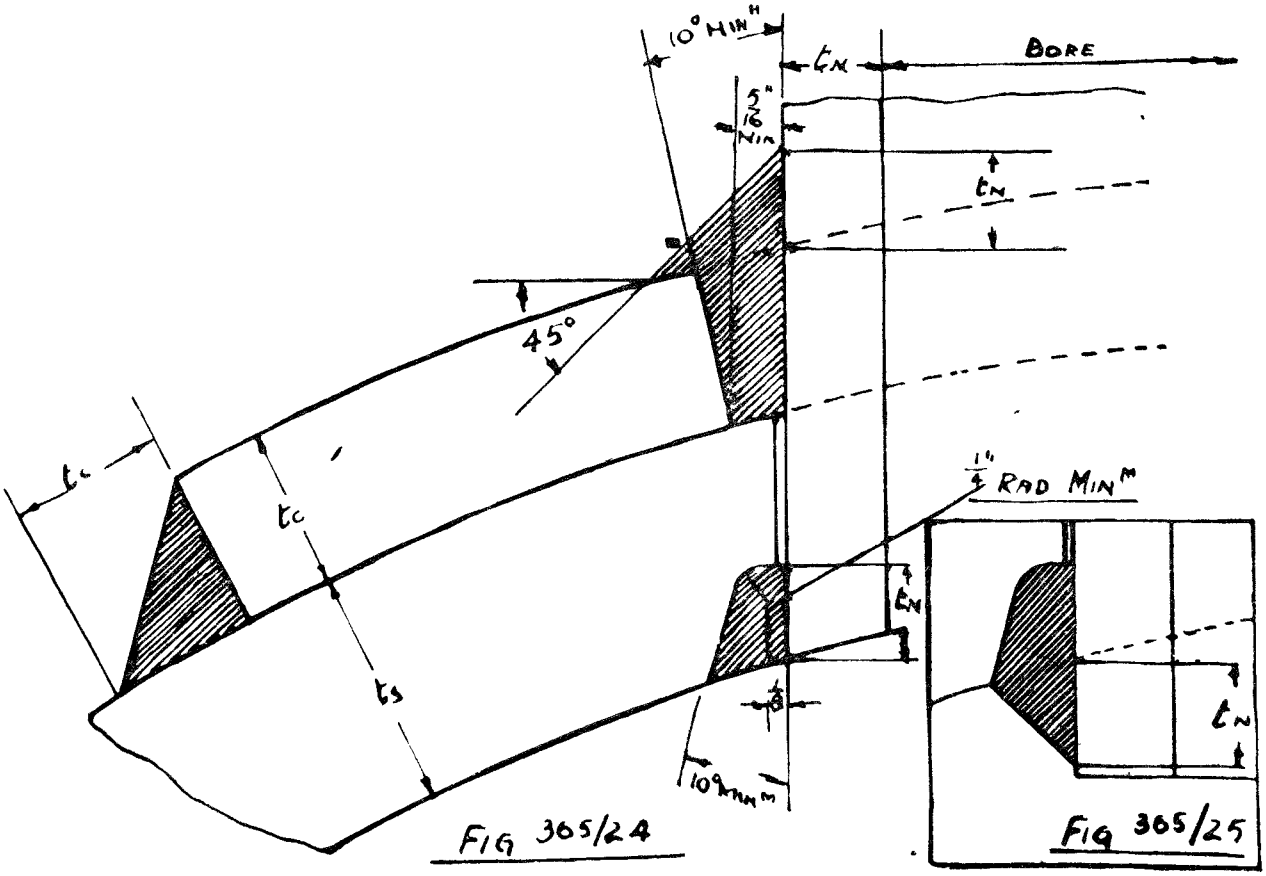


FIG 365/24

FIG 365/25

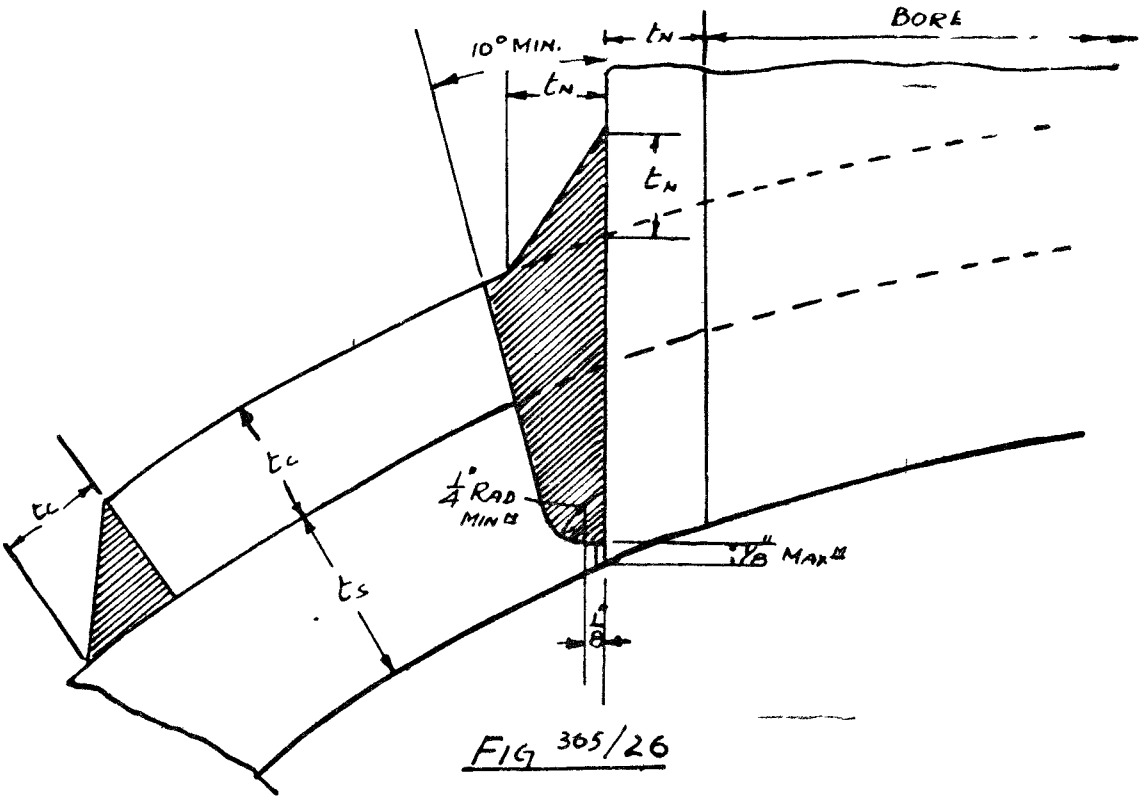


FIG 365/26

THE TYPE SHOWN IN FIG NO 365/26 IS NOT PERMITTED WHERE THE INSIDE OF THE VESSEL IS ACCESSIBLE FOR WELDING. FIG NO 365/27 IS PREFERRED WHERE THE INSIDE OF THE BRANCH IS ACCESSIBLE FOR WELDING WHERE IT JOINS THE SHELL.

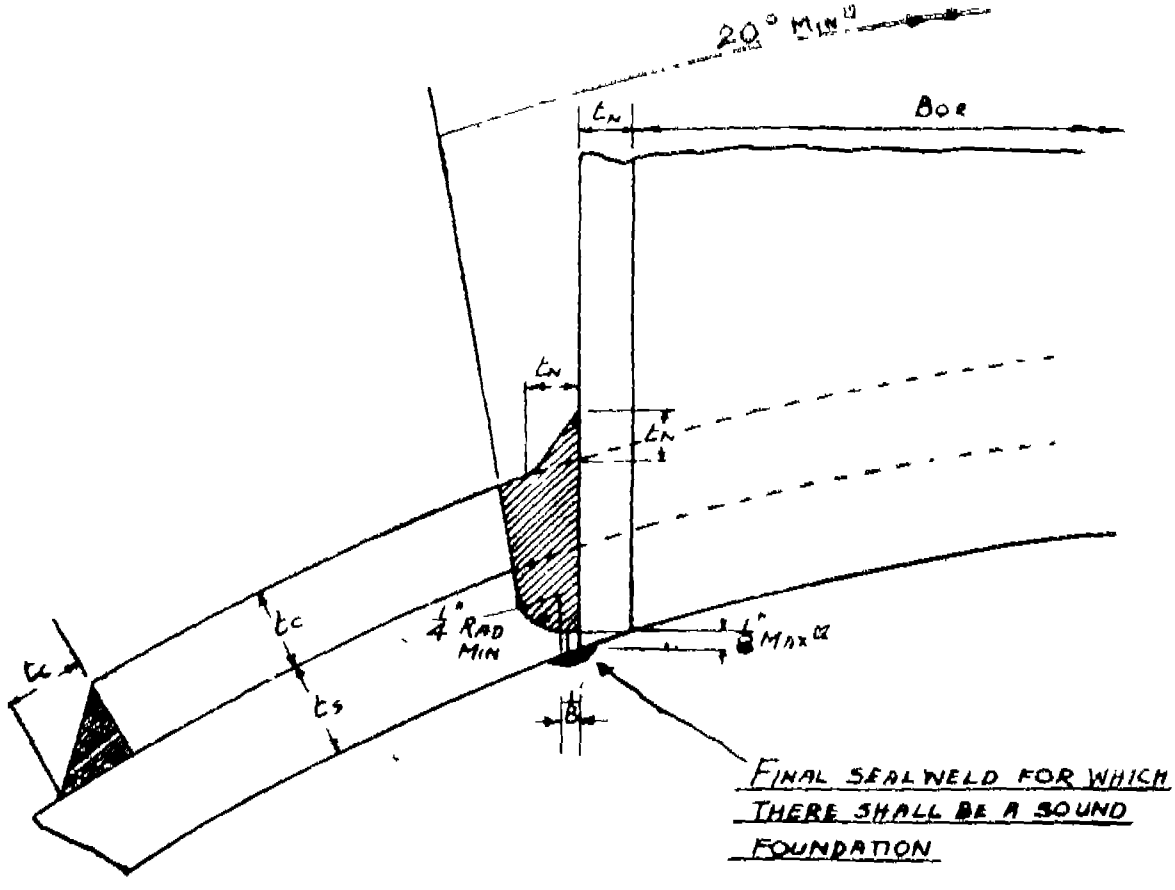


FIG 305/27

THE TYPE SHOWN IN FIG 305/27 IS NOT PERMITTED WHERE THE SHELL THICKNESS EXCEEDS 1 INCH

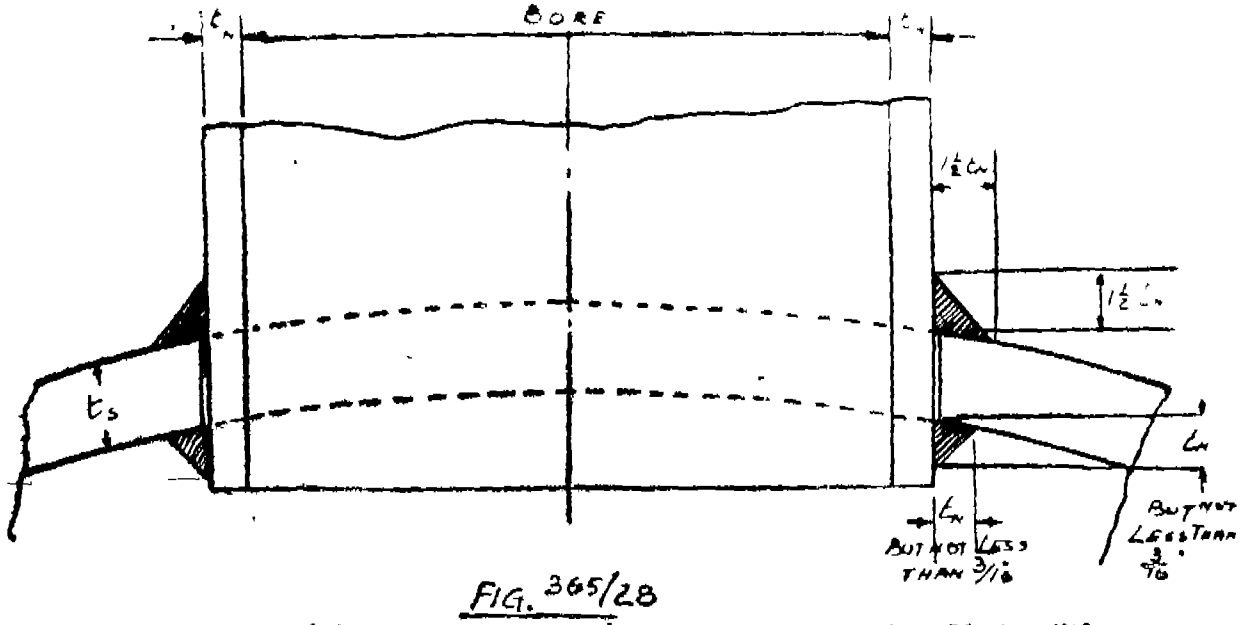


FIG. 365/28

TYPE SHOWN IN FIG 365/28 IS NOT PERMITTED WHERE ANY OF THE FOLLOWING LIMITS IS EXCEEDED.

SHELL THICKNESS. ¾ IN.
DESIGN PRESSURE 105 LBS/SQ. IN.
DESIGN TEMPERATURE 340°F.

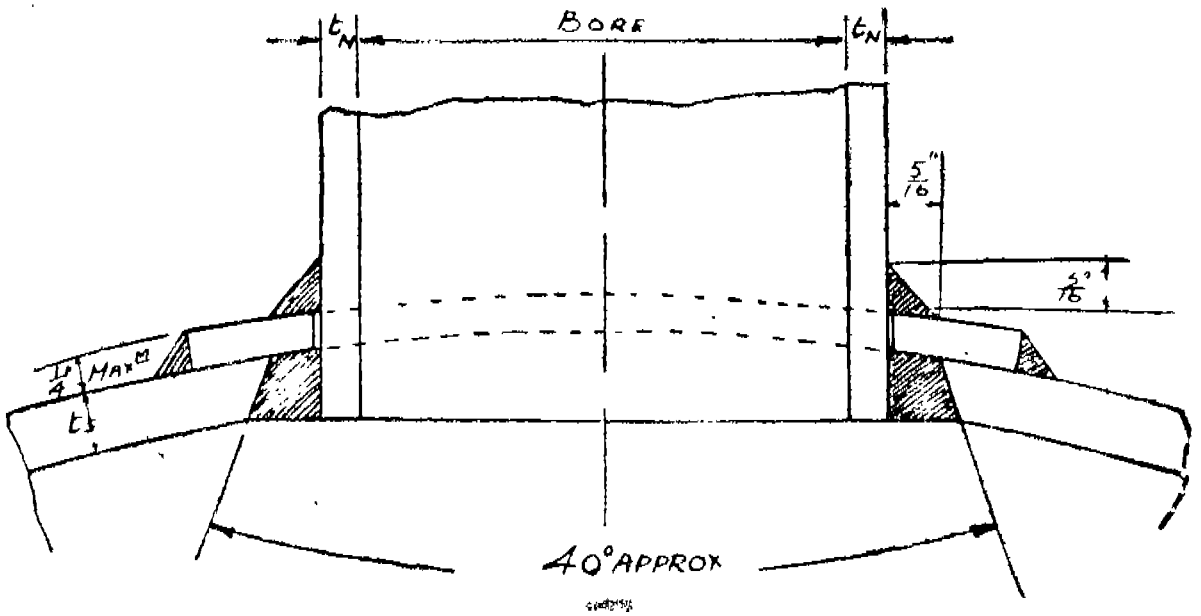


FIG 365/29

THIS TYPE AVOIDS THE PREPARATION OF GROOVES IN THIN SHELL PLATE
THE RING IS A BACKING RING ONLY AND NOT A COMPENSATING RING.
THE TYPE SHOWN IN FIG 365/29 IS NOT PERMITTED WHERE ANY OF THE FOLLOWING LIMITS IS EXCEEDED

SHELL THICKNESS 1/2"

DESIGN PRESSURE 105 LBS/SQ IN

DESIGN TEMPERATURE 340°F.

Branches of not more than 1½ ins. nominal bore may be screwed into the shell with a taper thread and seal welded, provided that the thickness of the shell is sufficient to allow for a length of thread equal to the diameter of the branch. Where the thickness of the shell is not sufficient for this purpose, a boss may be welded on so that the total thickness of the boss and shell is at least equal to the required length of thread. Methods of attachment of such bosses are shown in Figures 365/30 to 365/34.

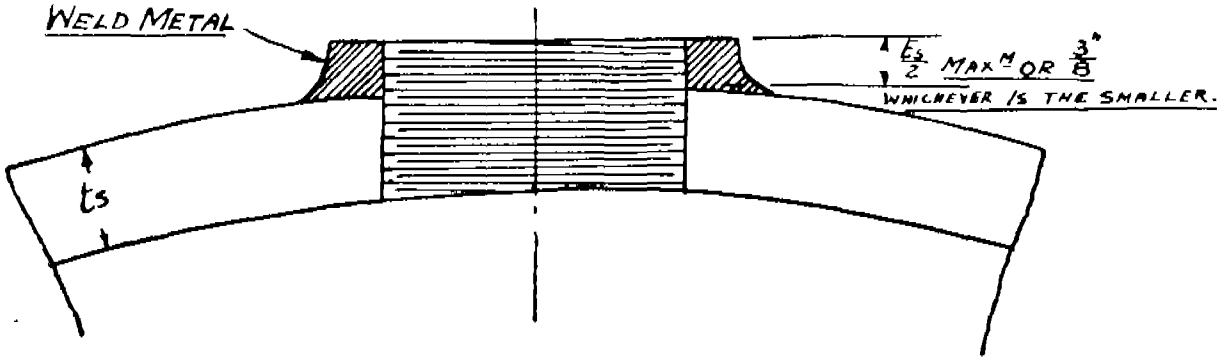


FIG. 365/30.

TAPPED BOSSES EXCEEDING 1½" STANDARD PIPE SIZE ARE NOT PERMITTED.

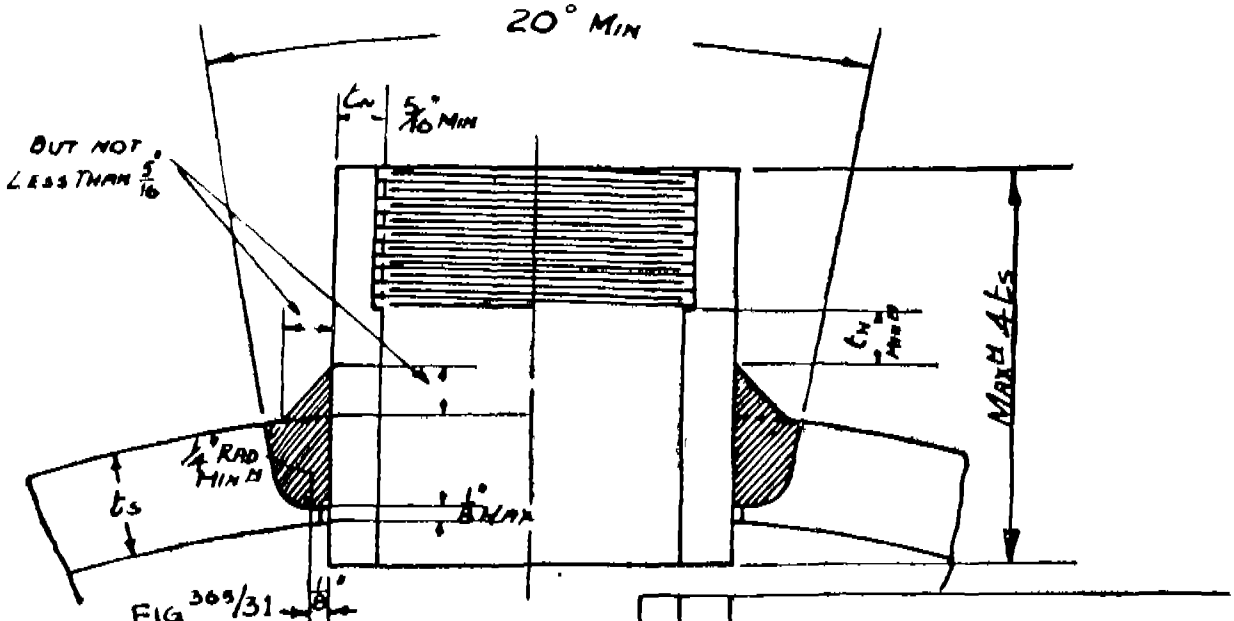


FIG 365/31

THE TYPE SHOWN IN FIG 365/31 IS NOT PERMITTED WHERE THE INSIDE OF THE SHELL IS ACCESSIBLE FOR WELDING

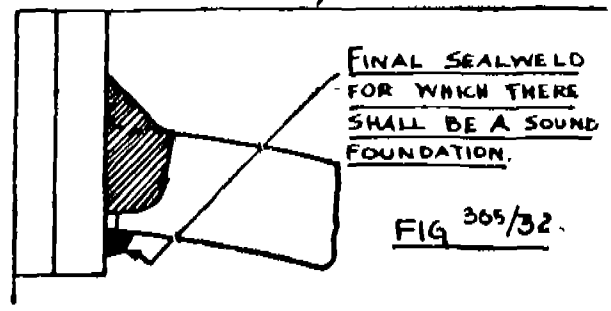
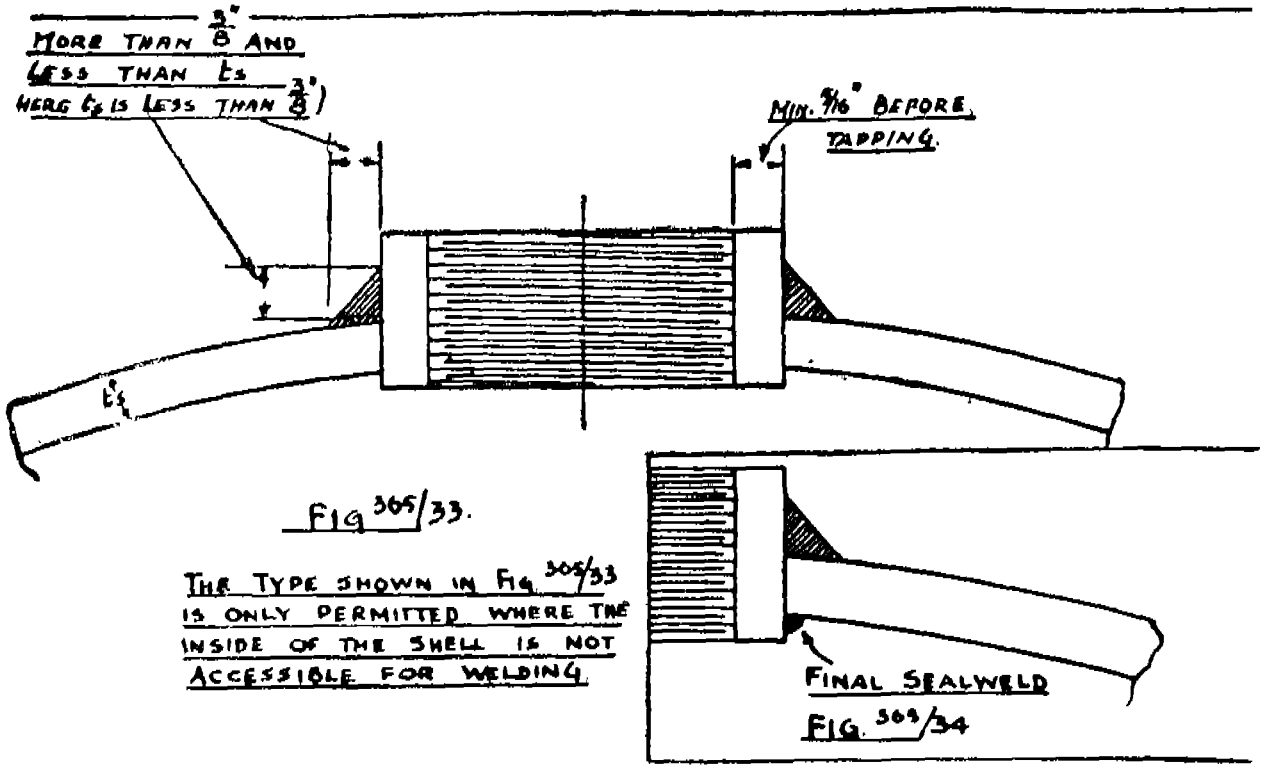


FIG 365/32.



THE TYPES SHOWN IN FIGS. 305/33 AND 305/34 ARE NOT PERMITTED WHERE ANY OF THE FOLLOWING LIMITS IS EXCEEDED:-

SHELL THICKNESS 3/4 INCH

DESIGN PRESSURE 150 lb/sq IN.

DESIGN TEMPERATURE 500° C

TAPPED BOSSES EXCEEDING 1½" STANDARD PIPE SIZE ARE NOT PERMITTED

Branches may be provided with flanges for ordinary bolted joints. Joints of special type may also be used. Flanges for ordinary bolted joints shall be in accordance with the appropriate table in Appendix E and shall be forged solid with the branches or attached in accordance with Regulation 356 or 357. They shall be machined on the jointing and bolt bearing surfaces.

Where pressed plate saddles are used, they shall be formed to bed closely to the shell and shall be machined on the face adjoining the connection and machined or flame cut by machine on the edges. The studs for the attachment of the connection, if screwed through the saddle, shall each be fitted with a nut on the inside. Where the stud holes do not penetrate through the saddle, the length of the screwed portion of the stud in the plate shall be not less than the diameter of the stud.

The joint faces of all pads shall be machined.

The pads shall be sufficiently thick to allow the drilling of stud holes for connections without the inner surface being pierced. The length of the screwed portion of the stud in the pad shall be not less than the diameter of the stud. Methods of attachment of pads secured by welding are shown in Figures 365/35 to 365/41, but where pads of the type shown in Figure 365/35 are used they shall be formed to bed closely to the shell.

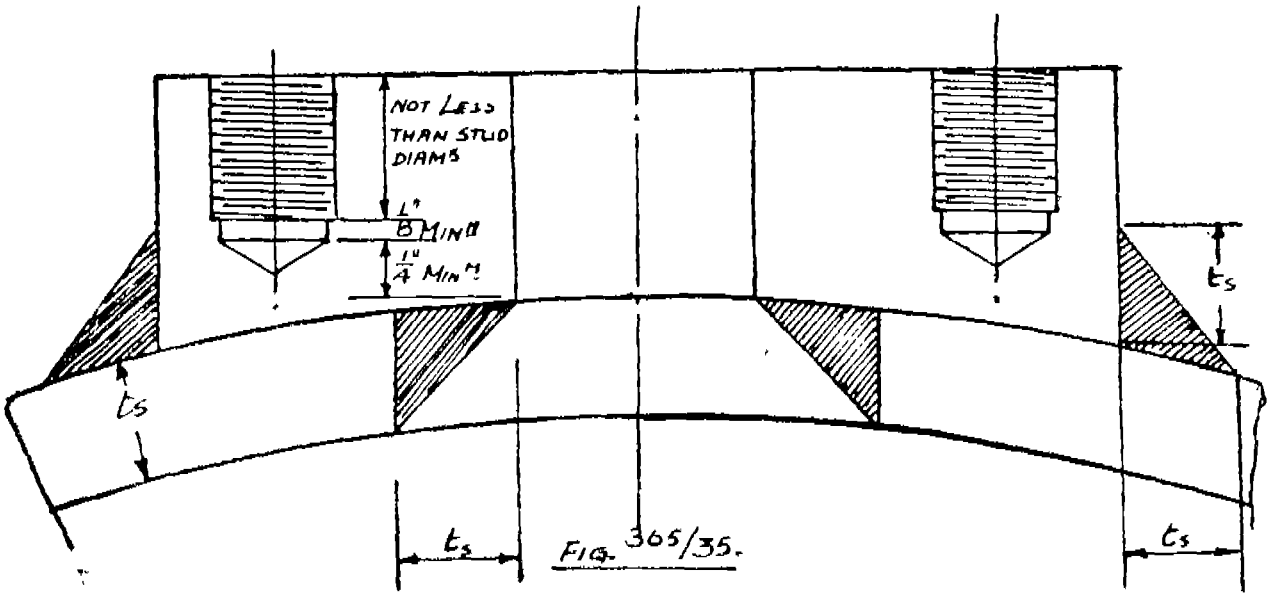


FIG. 365/35.

THE TYPE SHOWN IN FIG. 365/35 IS NOT PERMITTED WHERE THE SHELL THICKNESS EXCEEDS 3/4 INCH

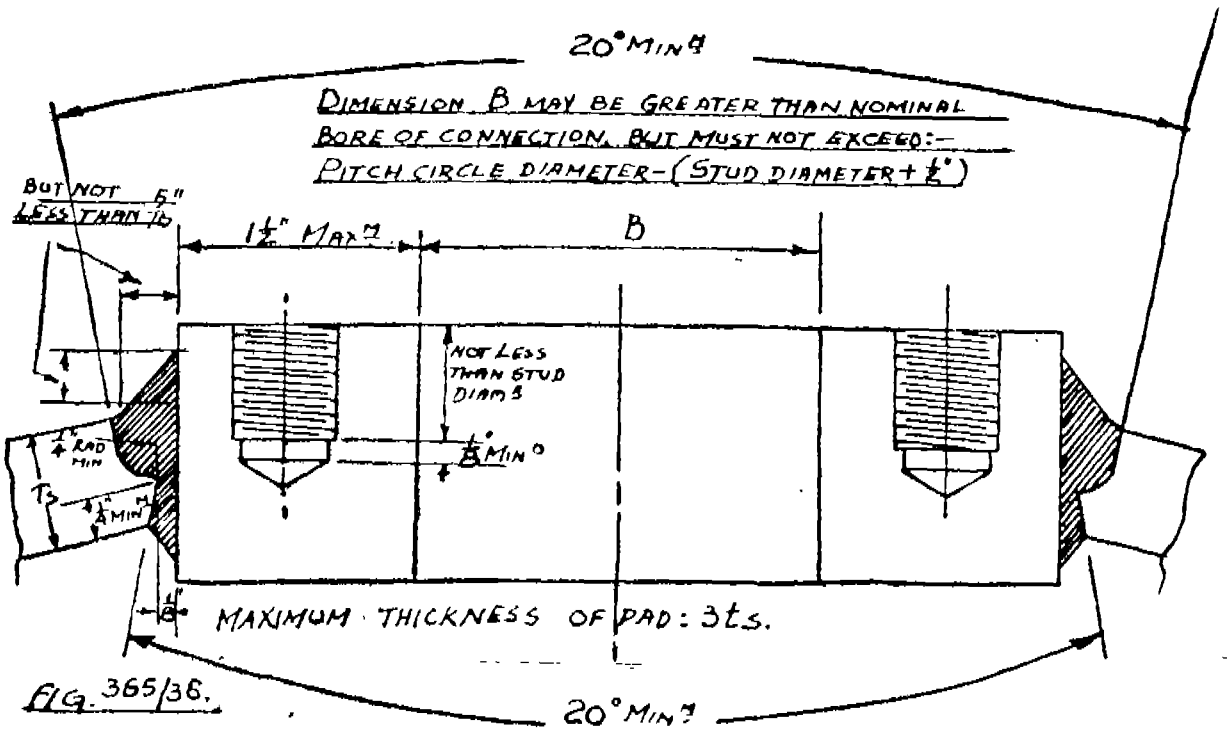


FIG. 365/36.

WELDING PROCEDURE FOR TYPE SHOWN IN FIG. 365/36 TO BE AS FOR DOUBLE WELDED BUTT JOINT. OUTER WELD TO BE MADE FIRST. BACK OF OUTER WELD TO BE CHIPPED OUT BEFORE COMMENCEMENT OF INNER WELD. BUT DEEP PENETRATION WELDING MAY BE USED, SUBJECT TO PROOF OF REQUISITE PENETRATION BEING PRODUCED BY THE MANUFACTURER WHERE CALLED FOR BY THE INSPECTING AUTHORITY.

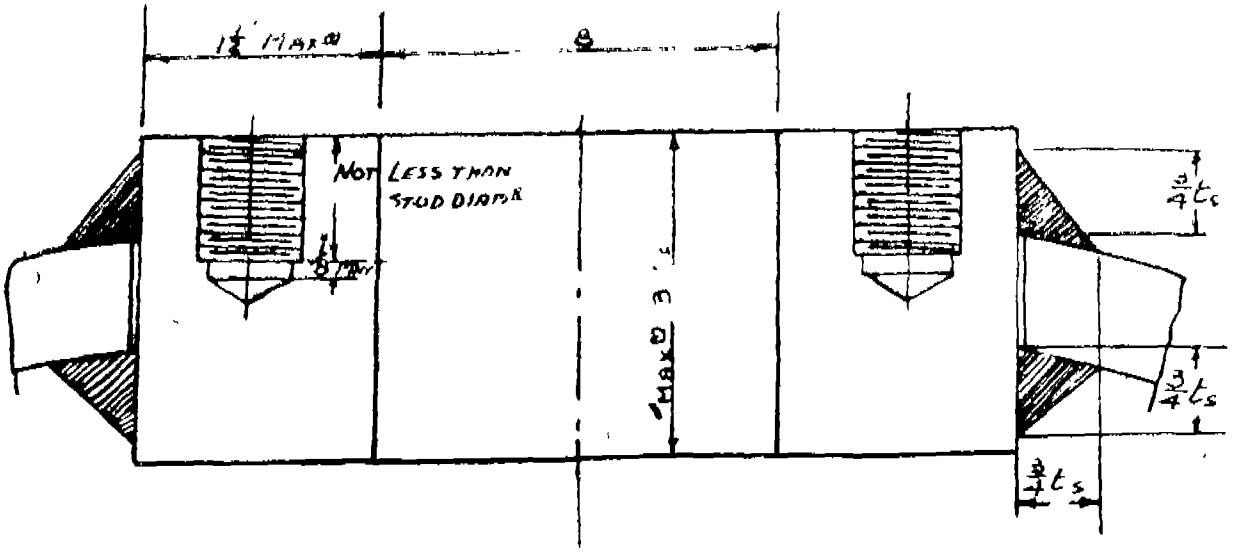


FIG 365/37

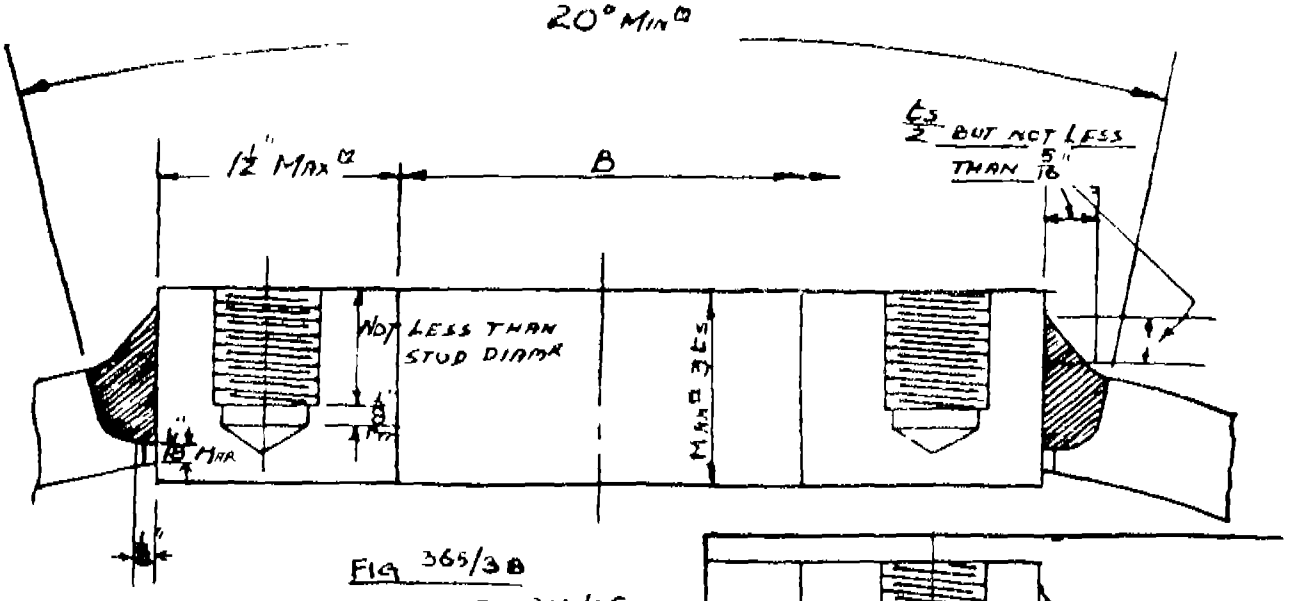
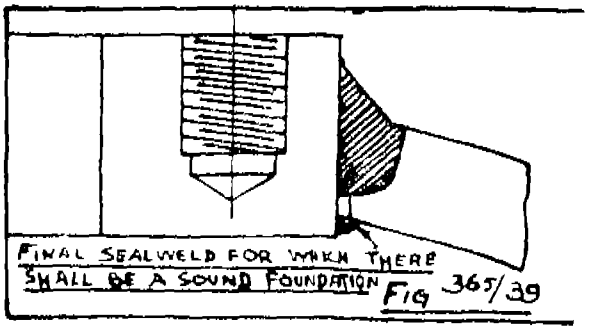


FIG 365/38

THE TYPE SHOWN IN FIG 365/36 IS NOT PERMITTED WHERE THE INSIDE OF THE SHELL IS ACCESSIBLE FOR WELDING



FINAL SEALWELD FOR WHICH THERE SHALL BE A SOUND FOUNDATION FIG 365/39

DIMENSION B MAY BE GREATER THAN NOMINAL BORE OF CONNECTION, BUT MUST NOT EXCEED:-

PITCH CIRCLE DIAMETER MINUS (STUD DIAMETER + ½)

THE TYPES SHOWN IN FIGS 365/37, 365/38 AND 365/39 ARE NOT PERMITTED WHERE THE SHELL THICKNESS EXCEEDS ¾ INCH

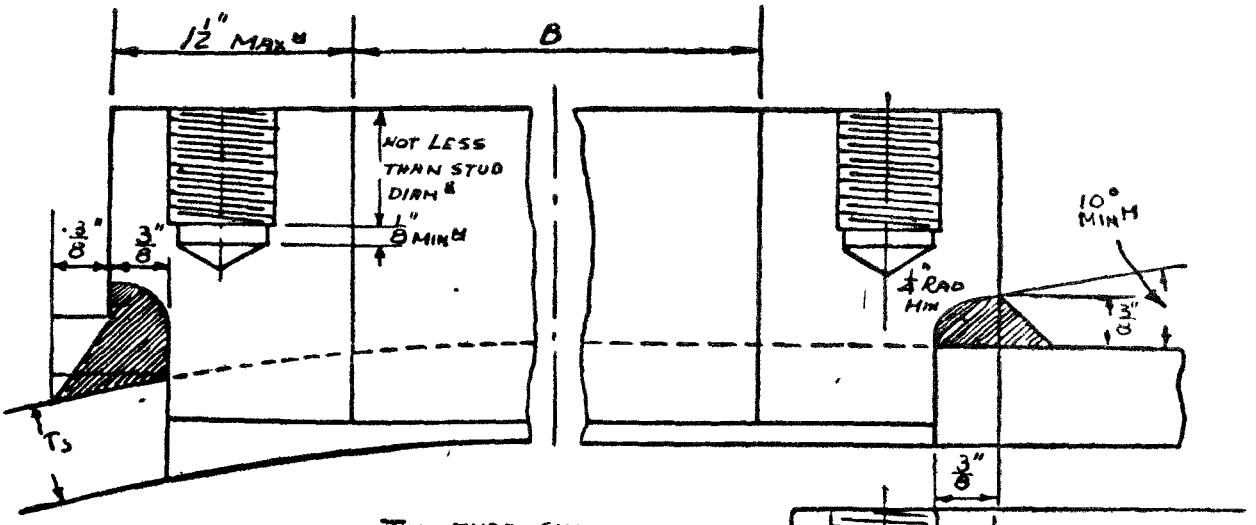


FIG. 365/40

THE TYPE SHOWN IN FIG. NO 365/40 IS NOT PERMITTED WHERE THE INSIDE OF THE SHELL IS ACCESSIBLE FOR WELDING.

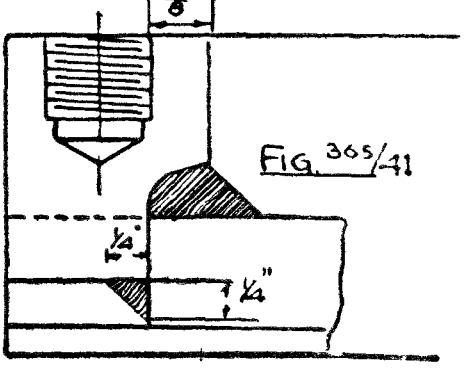


FIG. 365/41

DIMENSION B MAY BE GREATER THAN NOMINAL BORE OF CONNECTION, BUT MUST NOT EXCEED:-

PITCH CIRCLE DIAMETER MINUS (STUD DIAMETER + 1/2")

THE TYPES SHOWN IN FIGS. 365/40 AND 365/41 ARE NOT PERMITTED WHERE THE SHELL THICKNESS EXCEEDS 3/4 INCH.

Tapped bosses of not more than 1½ ins. standard pipe size, welded to the shell, may be used for design pressures not exceeding 200 lbs./sq. in. and design temperatures not exceeding 650°F. Such bosses shall have taper threads. Methods of attachment of bosses secured by welding are shown in Figures 365/30, 365/34.

All welded attachments other than flange connections shall be by the metal-arc process and the electrodes used shall comply with the requirements of Regulations 94 to 98. Where tack welds are used they shall be sound and unless cut out, shall be carefully fused into the main runs.

All parts secured by welding shall be effectively heat treated after completion of all welding and before hydraulic test.

(f) SHELL JOINTS

(1) Riveted Shells.—Preparation of plates, butt straps, rivet holes and riveting shall comply with the relevant Regulations of Chapter III.

Longitudinal joints of riveted, shells may be lap jointed or fitted with double butt straps, but in cases where the design pressure exceeds 130 lbs./sq. in. or the product of the design pressure in lbs./sq. in. and maximum internal diameter in inches exceeds 9,500, the longitudinal joints shall be butt jointed with double cover straps. The design of riveted joints shall be in accordance with Regulations 177 to 184.

(2) Fusion Welded Shells.—These shall be classified as follows:—

Class I.—All shells designed for a pressure exceeding 500 lbs./sq. in. or shells of which the product of the designed pressure in lbs./sq. in. and the internal diameter in inches exceeds 21,000 or the designed temperature exceeds 650°F.

Class II. All shells designed for working below the limits specified for Class I

Fusion welds, preparation of seams, the method of formation of cylindrical shells including heat treatment after bending, method of making welded seams, types of welded joints, test plates and circularity of shells shall all conform to the requirements of Chapter V, except for the following, namely,—

Wherever practicable, seams shall be welded from both sides of the plate. Additional runs of metal shall be deposited at both surfaces of the welded seams to build up to a thickness 10 per cent greater than thickness of the plate. The surfaces of welds wherever carried out on both sides shall be ground smooth and flush with the respective surfaces of the plates. Where the seam is welded from one side only, these provisions shall apply to the exposed surface of the weld.

Tests for Class I fusion welded seams shall comply with the requirements of the relevant Regulations of Chapter V.

Tests for Class II fusion welded seams shall comply with the requirements of those of Chapter XII, except that an additional provision for one micro and macro examination shall be made.

All shells shall be stress relieved by heat treatment after completion of all welding and before the hydraulic test. The heat treatment shall conform to the requirements of Chapter XII.

(3) *Seamless Forged Shells.*—These shall comply with the requirements of Regulations 235 to 243.

366. DETERMINATION OF WORKING PRESSURE

(a) SHELLS

The maximum working pressure of shells shall be determined by the following formula:—

$$W.P. = \frac{2fE\ (T-\cdot 03)}{D\ (T-.03}$$

Where, T is Thickness in inches.

D is Maximum internal diameter in inches.

W. P. is Working pressure in lbs./sq. inch.

f is Permissible working stress in lbs./sq. inch at the working metal temperature.

E is Efficiency of longitudinal riveted seam as given in Regulation 177.

is Efficiency factor for fusion welded shells as given in table below.

is 1.00 for seamless shells or shells made from seamless tubes.

is Efficiency of ligaments between holes or openings in shell, expressed as a fraction.

Class	Efficiency factor E
I	0·90
II	0·75 if welded from both sides. 0·50 if welded from one side only.

Minimum thickness of shells shall be as given in table below :—

Classification	Internal diameter ins.	Minimum thickness in
Fusion welded class I.		1/4
Fusion welded Class II, and shells other than fusion welded shells.	Upto and including 24	1/4
	Over 24 and upto & including 36	5/16
	Over 36	3/8

The maximum permissible stresses for cylindrical parts of seamless, fusion welded and riveted shells shall not exceed those given below:—

Design Temperature °F	Tensile strength 28-32 tons/sq. in.	Tensile strength 32-36 tons/sq. in.	Tensile strengh. 34-38 tons/sq. in.
	Seamless, fusion welded or riveted shells	Seamless shells	Seamless shells
	lbs./sq. in.	lbs./sq. in.	lbs./sq. in.
Upto 650	15,700	18,000	19,000
700	15,200	17,200	18,200
750	13,400	14,800	15,500
800	11,300	12,100	12,500
850	8,900	9,300	9,500
900	6,300	6,300	6,300

Intermediate values may be obtained by linear interpolation.

Where steels are intended for service at temperatures in excess of 700°F, this shall be so stated and silicon contents shall be not less than 0.10 per cent or alternatively, the material must pass the 'Proof test for creep quality of carbon steel plate of boiler plate quality' as in appendix D.

The maximum permissible stress (f) for shells made from weldless pipes shall be those as given in table below:—

Design temperature		Cold drawn or Hot-finished weldless steel
	°F	lbs./sq. in.
Upto	500	13,000
	550	12,500
	600	11,800
	650	11,100
	700	10,300
	750	9,500
	800	8,500
	850	7,500
	875	6,800
	900	5,600

Intermediate values may be obtained by linear interpolation.

The suitability of circumferential seams of riveted shells including the seams Joining the ends of the cylindrical parts of the shell shall be verified by the following formula:—

$$W.P. = \frac{Ef\,(T-\cdot 06)}{CD}$$

Where E = Joint efficiency expressed as a fraction calculated by formulae in Regulation 177.

W.P. = Working pressure, in lbs./sq. in.

D = Inside diameter of the outer strake of plating of the cylindrical shell, in inches.

T = Thickness of the plate, in inches.

F = Maximum permissible working stress in lbs./sq. in. at the working metal temperature given in column 1 of table of stresses in sub-regulation (a) above.

C = 0.257 where the seams are made with lap joints and treble riveted.

= 0.264 where the seams are made with lap joints and are double riveted.

= 0.300 where the seams are made with lap joints and are single riveted.

Compensation for openings in shells.—Where the major axis or diameter of any hole cut in cylindrical part of the shell is greater than $2\frac{1}{2}$ times the thickness of the shell plate plus $2\frac{3}{4}$ inches, compensation shall be provided.

The sectional area to be compensated measured in the plane parallel to the longitudinal axis of the shell, which makes this area a maximum, shall be the product of the length of the opening (including any rivet holes in the plane) and the thickness of a seamless shell of similar material calculated in accordance with Equation 72 (Regulation 270) for the same conditions of pressure and temperature.

Where frames, pads or branches are secured by rivets, the compensating area shall be calculated by the method given in Regulation 170.

Where frames, pads or branches are secured by welding, the compensating area shall be calculated by the method given in Regulation 279.

(b) END PLATES

(1) *Dished End Plates.*—The maximum working pressure of dished end plates with pressure on concave side shall be determined by Regulations 276 to 278.

For manholes formed by welding on pressed frames to dished end plates as in Figure No. 366/1.

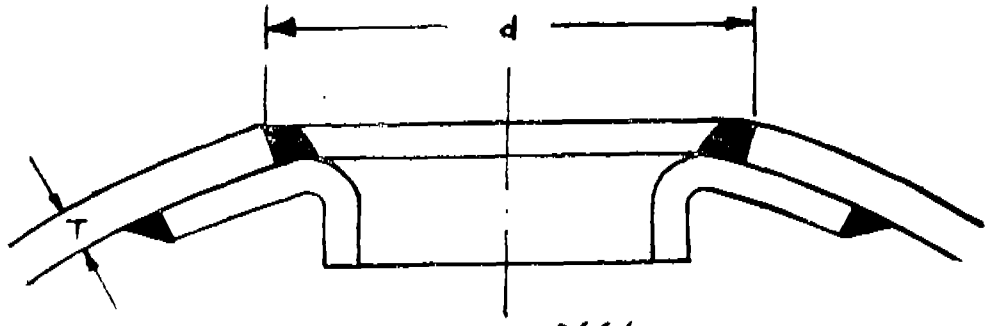


FIG 366/1.

ELLIPTICAL MANHOLE FRAME WELDED TO DISHED END PLATE.

NOTE: THE DIAMETER OF THE COMPENSATING PLATE SHALL NOT EXCEED TWICE THE OUTSIDE DIAMETER OF THE BRANCH.

The value of F = 1.00 where compensation is equal to or greater than that required under Regulation 637.

$$\frac{\text{Diameteral cross sectional area of shell openings to be compensated}}{\text{Diameteral cross sectional area of frame and/or ring.}}$$

For ends which are butt welded to the cylindrical parts of the shell the thickness of the edge of the flange for connection to the cylindrical part of the shell shall be not less than seamless unpierced shell as determined by Equation 72.

(2) *Flat End Plates.*—The maximum working pressure for welded in flat end plates as in figures Nos. 365/2, 365/3 and 365/4, shall be determined by the following formula:—

$$\text{W.P.} = \frac{fT^2}{Cd^2}$$

Where
- T = Minimum thickness of end plate, in inches.
- d = Internal diameter of shell, in inches.
- W.P. = Working pressure, in lbs./sq. in.
- C = 0.28
- f = Maximum permissible working stress in lbs./in. as in the table below:—

Working metal temperature	Tensile strength 24—28 tons per sq. in.	Tensile strength 26—30 tons/sq. in.	Tensile strength 28—32 tons/sq. in.
°F	lbs./sq. in.	lbs/sq. in.	lbs./sq. in.
Upto 650	13,400	14,500	15,700
700	13,200	14,300	15,200
750	12,000	13,700	13,400
800	10,500	10,900	11,200
850	8,500	8,500	8,900
900	6,300	6,300	6,300

Intermediate values may be obtained by linear interpolation.

Where steels are intended for service at temperatures in excess of 700°F. this shall be so stated and silincon content shall not be less than 0·10 per cent or alternatively, the material shall pass the 'Proof test for creep quality of carbon steel plates of boiler plate quality' as in Appendix D.

Where flat end plates are bolted to flanges as in Figure 365/5 the dimensions of the flanges shall be as given in Appendix E. The thickness of the end plates shall be not less than that of the corresponding flanges.

Where the diameter of a hole in the flat end plate exceeds $2\frac{1}{2}T + 2\frac{1}{4}$ inches compensation shall be provided in accordance with Regulations 170 and 279.

(C) BRANCHES

Where branches or saddles are secured to the shell by riveting or by studs. the minimum thickness of the flange adjoining the shell shall be in accordance with the following table:—

TABLE

Thickness of shell plate	Minimum thickness of flange
in.—	in.
3/8 to 3/4	1/2
above 3/4 to 1	5/8
above 1 to 2	3/4
above 2	1

The actual dimensions of the flanges shall be governed by the requirements of compensation for the opening.

The dimensions of flanges of branches remote from the shell for ordinary bolted joints and those of bolts of all pads and saddles shall be in accordance with the appropriate table given in Appendix E for the working pressure and temperature corresponding to the design pressure and temperature of the shell. The dimensions of the flanges for special joints shall be subject to approval of the Chief Inspector of Boilers concerned.

The working pressure for the body of the branch shall be determined by the equation as given in sub-regulation (a) above, subject to the requirements of compensation for the opening.

Notwithstanding the result obtained from the equation the minimum thickness of the body of the branches shall be such that in no case does the total stress, resulting from the combination of the stress due to internal pressure and to all externally applied loads, exceed the permissible stress corresponding to the design temperature. The method of calculating the total stress shall be subject to the approval of the Chief Inspector of Boilers concerned. Where the magnitude of the externally applied loads cannot be determined, the minimum thickness of the body of the branch shall be as given in the following table:—

MINIMUM THICKNESS OF BRANCHES WHERE EXTERNAL LOADS ARE NOT KNOWN

Nominal bore of branch	Thickness of cylindrical part of shell	Minimum body thickness
in.	in.	in.
Upto and including $2\frac{1}{2}$	$\frac{1}{4}$ and above	3/8
Over $2\frac{1}{2}$ upto and including $4\frac{1}{2}$	7/8 and above	7/16
Over $4\frac{1}{2}$ upto and including 8	1 and above	$\frac{1}{2}$
Over 8 upto and including 10	$1\frac{1}{4}$ and above	5/8
Over 10	$1\frac{1}{4}$ and above	Subject to approval of the Chief Inspector of Boilers concerned.

for thinner shells not less than one half the thickness of the cylindrical part of the shell.

[No. S&P-II/BL-318(3)/52.]

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